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25 July 1985

China Report

SCIENCE AND TECHNOLOGY

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CHINA REPORT

SCIENCE AND TECHNOLOGY

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PEOPLE'S REPUBLIC OF CHINA

ABSTRACTS

NATIONAL DEVELOPMENTS

FUJIAN SIGNS COOPERATION PACT WITH CAS

OW180150 Beijing XINHUA Domestic Service in Chinese 0820 GMT 16 Jun 85

[By reporter Xiao Huijia]

[Text] Fuzhou, 16 Jun (XINHUA)--A long-term scientific and technological cooperation agreement between Fujian provincial people's government and the China Academy of Sciences [CAS] was signed in Fuzhou on 15 June. Hu Ping, governor of Fujian Province, and Lu Jiaxi, president of the CAS, affixed their signatures separately on the document.

The purpose of this agreement is to accelerate the transfer of scientific and technological results in order to promote Fujian Province's scientific, technological, and economic development. Both parties will exploit their respective advantages, and actively carry out effective cooperation in science and technology.

The agreement stipulates: Taking account of the needs of Fujian Province as well as the capabilities and conditions of the CAS, the latter will systematically provide Fujian Province with scientific and technological consultation services, including assisting Fujian Province in drawing up social, economic, scientific, and technological development program for its special economic zones, and open cities and regions. It will give advice concerning major projects to be imported, and help make adaptations and renovations for local operation. The CAS will actively organize its affiliated units in providing assistance to Fujian Province in its important projects in scientific research or production and technology. The academy will also transfer with compensation as many scientific and technological results as possible to Fujian Province. At the same time, it will help the province train different experts and technicians by conducting seminars, training classes, on-the-spot guidance, as well as recruiting graduate students from the province. On the other hand, beneficiaries of these various services in Fujian Province must accord rational financial compensation and rewards to the CAS-affiliated units and individuals providing services, undertaking projects, and carrying out personnel training.

Governor Hu Ping told reporters: The CAS is a treasure house of talents, knowledge, and information. By cooperating with it, Fujian Province, which implements special policies and flexible measures, will redouble its strengths, and speed up its economic development.

CSO: 4008/2007

NATIONAL DEVELOPMENTS

GUIZHOU LEADER ATTENDS NEW TECHNOLOGY GATHERING

HK080355 Guiyang Guizhou Provincial Service in Mandarin 2300 GMT 7 Jun 85

[Excerpts] Provincial-level affirmation was given on 7 June of the fruits of Guizhou's counterstrategy for dealing with the new technological revolution. The event was carried out under the auspices of the provincial economic and social development research center and the provincial science and technology commission. Provincial CPC Committee Secretary Zhu Houze and Vice Governor (Zhang Shukui) extended congratulations to the experts, scholars and science and technology workers who took part in formulating the counterstrategy.

Last October, as advocated by a responsible comrade of the provincial CPC Committee, the provincial economics center and [words indistinct] commission organized a Guizhou group for studying counterstrategy for dealing with the new technological revolution, composed of experts and scholars in natural and social sciences and responsible persons of departments concerned, to make an in-depth study of such counterstrategy. The entire study task was completed at the beginning of this month.

The counterstrategy proposed: Proceeding from the actual conditions in the province, we should apply new technology to transform and equip traditional industry. This is the priority task. We must also focus on microelectronics. At the same time, we must step up research in biological technology and organize its selective development. We must popularize and gradually research new materials. We must forge a large number of advanced typical examples. We must set up a system that can promote the development of the economy, science and technology, and society. We must practice an open-door policy for a long period, raise capital through various channels, and improve communications and transport conditions.

The affirmation of these reports on the fruits of research is of major strategic significance for seizing the opportunity [words indistinct], promoting the province's socialist modernization, formulating the province's economic, science and technology, and social development plans, and assisting the provincial CPC Committee and government in policymaking.

CSO: 4008/2007

NATIONAL DEVELOPMENTS

BRIEFS

NAN AND PING MEET SCIENTISTS--On 22 May afternoon, Comrades Xiang Nan and Hu Ping met with China's semiconductor expert Lin Lanying and four others who were on a study tour in Fujian, and listened to their views on how to develop economy, science and technology; train talented persons; and run the special economic zone well in Fujian. The provincial leaders asked them to come back more often to offer advice regarding Fujian's economic construction. Comrade Lin Lanying is a member of the Scientific Council of the Chinese Academy of Sciences. She was born in Putian City. The group arrived in Fujian on 10 May. They successively visited the Xiamen special economic zone, the Mawei development zone, Meizhou Wan, and some factories and universities. Comrades You Dexing and Zhang Gexin and leading cadres of the provincial economic committee, planning committee and scientific and technological committee held a discussion meeting with Lin Lanying's group on 21 May. They exchanged views on some questions concerning Fujian's science and technology, education, and economic construction. Comrade Lin Lanying and her party left Fuzhou yesterday. [Text] [Fuzhou FUJIAN RIBAO in Chinese 24 May 85 p 1 OW]

SCIENCE, TECHNOLOGY MEETING ENDS--The Third Congress of the provincial Scientific and Technological Association ended in Harbin on 16 June. The congress called on scientific and technological associations at all levels in the province to further arouse the enthusiasm and creativeness of the broad masses of the scientific and technological workers and the people to widely conduct mass scientific and technological activities and to dedicate themselves to accelerating our province's economic development. During the congress, representatives conscientiously studied and discussed the provincial CPC Committee's important decision on scientific and technological work and the speech of Chen Yunlin, deputy secretary of the provincial CPC Committee; discussed and adopted the work report delivered by Comrade Wang Jinlin on behalf of the second provincial scientific and technological association; and set forth opinions and suggestions on our province's economic, scientific and technological, scientific and technological association, and intelledtual work. The congress also elected the third committee of the provincial scientific and technological association. Wang Jinling was appointed as honorary chairman and (Yu Yaotai) was elected chairman of the committee. [Excerpt] [Harbin Heilongjiang Provincial Service in Mandarin 1000 GMT 16 Jun 85 SK]

CSO: 4008/2007

APPLIED SCIENCES

PRESSURE-COUPLED RESPONSE FUNCTION OF SOLID PROPELLANTS INCLUDING THOSE WITH NEGATIVE PRESSURE EXPONENTS

Beijing YUHANG XUEBAO [JOURNAL OF THE CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 1, Jan 85 pp 47-58

[Article by Xu Wengan [1776 3306 1626]]

[Text] Nomenclature

A $\equiv\frac{E_{ox}}{R^0T_s}\left(1-\frac{T_i}{T_s}\right)$

A_{ox} exponent factor of the rate of gasification of oxidizer

B $\equiv\frac{2R^0T_f^2}{(T_s-T_i)E_f}$

B_1 exponent factor in the formula for equilibrium evaporation pressure of oxidizer

C $\equiv\frac{B_1\left(1+\frac{G}{1-G}\frac{W_{AP(g)}}{W_G}\right)}{P\exp\left(\frac{q}{R^0T_s}\right)}-1$

c specific heat

D $\equiv A+\lambda_r(AB-A)$

E $\equiv\frac{C}{C+q/E_{ox}}\Omega+\lambda_i(AB-A)$

E_{ox} activation energy of the gasification reaction of oxidizer

E_f activation energy of the propellant gas-phase combustion process

F $\equiv\Omega+\lambda_i(AB-A)$

G mass fraction of oxidizer removed from the condensed-phase reaction

K velocity constant of the gas-phase reaction

Nomenclature [continued]

m	mass flow rate
n	burning speed pressure exponent
P	pressure
Q_F	heat of decomposition of unit-mass binder
Q_s	heat of interface reaction of unit-mass oxidizer
q	heat of evaporation of unit-mass oxidizer
q_g	heat flow from the gas-phase through the interface
Q_g	heat released from unit-mass gas-phase reaction
q_c	rate of net heat release due to interface reaction
Q_e	the real part
R^0	conventional gas constant
R_p	pressure response function $\equiv \frac{\tilde{m}}{\bar{m}} / \frac{\tilde{P}}{\bar{P}}$
s	$\equiv i\omega \frac{\rho\lambda}{m^2 c} \equiv i\Omega$ (i is the unit of imaginary number $\sqrt{-1}$)
T	temperature
T_f	adiabatic flame temperature of propellant
T_i	initial temperature of propellant
T_s	surface temperature of propellant
t	time
$W_{AP(g)}$	gram molecular weight of oxidizer vapor
W_G	gram molecular weight of gas product from oxidizer condensed-phase reaction
x	distance
α	mass fraction of oxidizer in propellant
γ	fraction of area covered by molten binder on the oxidizer surface
λ	coefficient of heat conduction of condensed-phase and solid-phase
ξ	nondimensional distance $\equiv \frac{mc}{\lambda} x$
ρ	density of condensed and solid phase
Ω	nondimensional frequency $\equiv \frac{\rho\lambda}{m^2 c} \omega$
ω	angular frequency

Superscript

$\overline{\quad}$	steady-state value or mean value
'	perturbed value
~	complex amplitude of disturbance
I	parameters corresponding to region I
II	parameters corresponding to region II

Subscript

i	imaginary part
r	real part
I	parameters corresponding to region I
II	parameters corresponding to region II
s	value at the interface, x=0 (adjacent to the condensed-phase)

I. Introduction

The primary mode of combustion instability in a solid-propellant rocket motor is acoustic instability, whose main source of gain is from the combustion response of solid propellants. Therefore, in designing solid propellant rocket engines, the ability to predict acoustic instability is very important, and accurate theoretical determination of combustion response is essential. In linear acoustic analysis, whose objective is to predict whether random pressure disturbances in a solid-propellant rocket engine will be amplified to cause acoustically unstable combustion, the pressure response function must be known. Therefore, the problem of pressure response of solid propellant has been studied extensively in the United States, the Soviet Union and other countries; an excellent review of this topic was given by Culick, F.E.C.[1] and Cohen, N.S.[3] Culick, F.E.C., et al[2,4] also investigated the pressure response function of a "plateau" propellant. However, in the opinion of this author, his theory is subject to questions because the steady-state combustion model and some other assumptions used in the investigation lacked experimental verification. For example, in order to illustrate the phenomenon of acoustic instability in a plateau propellant, the mass rate of gasification in the solid phase region was replaced by the following expression:

$$m = A_s P^{n_s} e^{-\frac{E_s}{R^0 T_s}}$$

from which the formula for pressure response function was derived:

$$R_p = \frac{nAB + n_s(\lambda - 1)}{\lambda + \frac{A}{\lambda} - (1 + A) + AB}$$

When comparing with experimental results, the value of n_s in the above formula was chosen to be 1. But we know that when the pressure exponent of the rate of gasification in the solid-phase reaction region is positive, the pressure exponent of the steady-state burning speed can hardly be zero. In this article, we shall not dwell on this point any further; instead, we shall derive a

new formula for the pressure response function based on a steady-state combustion model[1] which is valid for solid propellant burning speed characteristics with both positive and negative pressure exponents. This formula will be used to illustrate the phenomena of pressure coupling of various types of solid propellants whose burning speed pressure exponent may be zero, positive, or negative.

II. Physical--Chemical Model

As in the case of steady-state model,[1] a one-dimensional model is used and the burning surface is divided into two parts: one part consists of a region of the oxidizer surface covered by molten binder and the corresponding binder surface, the area ratio of this region to the total burning surface is denoted by γ; the other part consists of the oxidizer surface not covered by the binder and the remaining binder surface. These two parts are referred to as region I and region II, respectively, as shown in Figure 1. In addition, the combustion process of the solid propellant within each region is divided into three stages, which occur in three different phases (Figure 2).

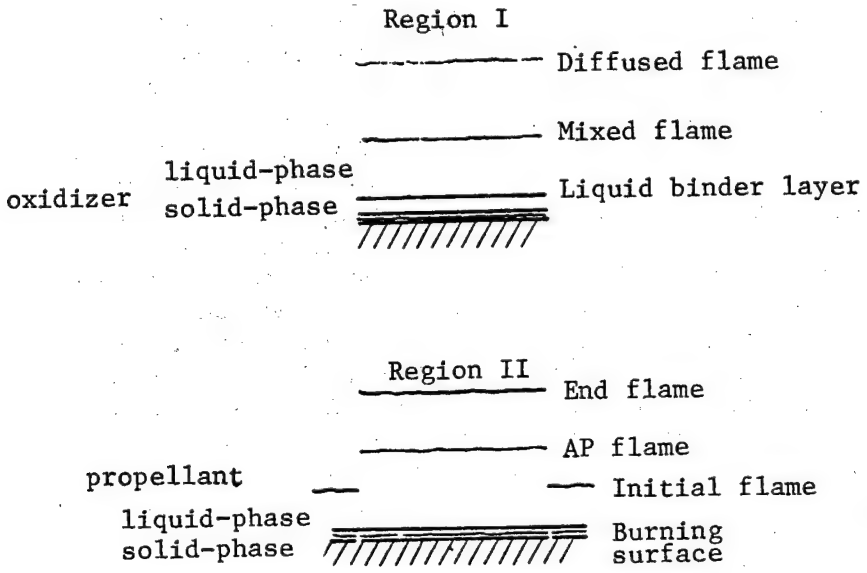

Figure 1. One-Dimensional Steady-State Model

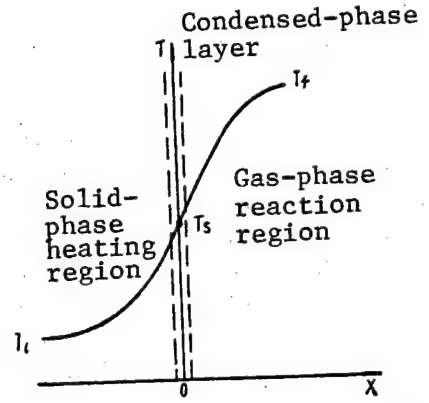

Figure 2. One-Dimensional Simplified Model

1. The solid-phase heating region inside the propellant is heated by the gas-phase flame region and the heat transmitted from the gasification region and the condensation reaction region;

2. Surface reaction of the oxidizer and thermal decomposition of the binder are taking place inside the condensation layer between the solid-phase and the gas-phase; this process primarily involves condensed-phase reactions and gasification reactions. Since region I differs from region II, one must take into consideration the gasification process associated with the condensed-phase reaction and the process of reverse gasification between the molten binder and the layer covering the oxidizer surface as well as the oxidizer underneath;

3. A combustion process involving diffusion, mixing and chemical reactions in the gas-phase is taking place.

III. Mathematical Treatment

To facilitate mathematical treatment, the following assumptions are made:

1) The effect of heat loss is negligible.

2) The solid propellant is incompressible, uniform and isotropic.

3) The condensed-phase layer between the solid-phase and the gas-phase is an infinitesimally thin planar surface. Within this plane, the condensed-phase reaction and the gasification reaction of the oxidizer (region I and region II each has its own reaction rules), as well as the high-temperature thermal decomposition of the binder are taking place. This plane is called the interface.

4) The specific heat is constant for all three phases: solid, condensed and gas.

5) The gas-phase reaction can be regarded as a quasi-steady process.

6) The effect of condensed-phase reaction on the pressure disturbance can be neglected.

7) The distances are sufficiently small so that terms containing second or higher order disturbances can be neglected.

As in the case of a conventional model, we choose a coordinate system which is moving toward the interior of the solid-phase at the instantaneous burning speed of the propellant. Thus, the origin of the coordinate system is always at the interface of the solid-gas phase.

We shall treat region I and region II separately.

Region I

(A) Basic Equations

1) The nonsteady heat conduction equation in the solid-phase heating region is

$$\lambda\frac{\partial^2 T}{\partial x^2}-mc\frac{\partial T}{\partial x}=\rho c\frac{\partial T}{\partial t} \tag{1}$$

2) Taking into account the presence of condensed-phase reaction and reverse gasification between the binder and the oxidizer cover and the oxidizer underneath, then from Reference 1 we can write the mass rate of gasification of the propellant as:

$$m=\frac{1}{\alpha}\cdot\frac{1}{1-G}A_{0x}\exp\left(-\frac{E_{0x}}{R^0T_s}\right)\left[1-\frac{P\exp\left(\frac{q}{R^0T_s}\right)}{B_1\left(1+\frac{G}{1-G}\frac{W_{AP(g)}}{W_G}\right)}\right] \tag{2}$$

3) In a quasi-steady state, the mass burning rate in the gas-phase reaction region can be expressed as[5]

$$m = KP^{n}\exp\left(-\frac{E_f}{2R^0T_f}\right) \tag{3}$$

4) The equation of energy conservation within the infinitesimally thin condensed-phase layer can be derived as follows.

The difference between the heat flux q_g from the gas-phase combustion region and the heat flux to the solid-phase $\lambda\frac{\partial T}{\partial x}\Big|_{x=0}$ should be equal to the heat generated from the condensed-phase reaction and the gasification reaction within the condensed-phase layer, i.e.,

$$q_g - \lambda\frac{\partial T}{\partial x}\Big|_{x=0} = q_c$$

In the moving coordinate system, $q_g = m[Q_g - c(T_f - T_s)]$, and $q_c = m[aQ_s - (1-a)Q_F]$, where Q_g is the heat released from a unit-mass gas reaction, Q_s is the algebraic sum of the thermal effects of the condensed-phase reaction and gasification reaction of the oxidizer, and Q_F is the thermal effect due to the high-temperature thermal decomposition of the binder. Substituting into the above equation, we get:

$$\lambda\frac{\partial T}{\partial x}\Big|_{x=0} + m[aQ_s - (1-a)Q_F - Q_g + c(T_f - T_s)] = 0 \tag{4}$$

(B) Linearization

1) First, equation (1) is linearized by assuming

$$\left.\begin{aligned} m(t) &= \bar{m} + R_e\{\tilde{m}e^{i\omega t}\} \\ T(x,\ t) &= \bar{T}(x) + R_e\{\tilde{T}(x)e^{i\omega t}\} \end{aligned}\right\} \tag{5}$$

By substituting into equation (1), neglecting high-order terms, and using the steady-state condition

$$\lambda\frac{d^2\bar{T}}{dx^2} - \bar{m}c\frac{d\bar{T}}{dx} = 0 \tag{6}$$

equation (1) becomes: $R_e\left\{\lambda\frac{d^2\tilde{T}}{dx^2}e^{i\omega t}\right\} - R_e\left\{\tilde{m}e^{i\omega t}c\frac{d\bar{T}}{dx}\right\} - R_e\left\{\bar{m}e^{i\omega t}c\frac{d\tilde{T}}{dx}\right\} = R_e\{\rho c\tilde{T}i\omega e^{i\omega t}\}$,

Since the equation should be valid at any time t, it follows that

$$\lambda\frac{d^2\tilde{T}}{dx^2} - \bar{m}c\frac{d\tilde{T}}{dx} - \tilde{m}c\frac{d\bar{T}}{dx} = i\omega\rho c\tilde{T} \tag{7}$$

Let

$$\left.\begin{aligned} \xi &\equiv \frac{\bar{m}c}{\lambda}x \\ S &\equiv i\omega\frac{\rho c}{\bar{m}^2 c} = i\Omega \end{aligned}\right\} \tag{8}$$

then equations (6), (7) can be rewritten as follows:

$$\frac{d^2\bar{T}}{d\xi^2} - \frac{d\bar{T}}{d\xi} = 0 \tag{9}$$

$$\frac{d^2\tilde{T}}{d\xi^2} - \frac{d\tilde{T}}{d\xi} - S\tilde{T} = \frac{\tilde{m}}{\bar{m}}\frac{d\bar{T}}{d\xi} \tag{10}$$

2) Similarly, in equation (2), let:

$$\left.\begin{aligned} m &= \bar{m} + m' = \bar{m} + R_e\{\tilde{m}e^{i\omega t}\} \\ T_s &= \bar{T}_s + T_s' = \bar{T}_s + R_e\{\tilde{T}_s e^{i\omega t}\} \\ P &= \bar{P} + P' = \bar{P} + R_e\{\tilde{P}e^{i\omega t}\} \end{aligned}\right\} \tag{11}$$

Dividing equation (2) by the steady-state condition

$$\bar{m} = \frac{1}{\alpha}\cdot\frac{1}{1-G}A_{0x}\exp\left(-\frac{E_{0x}}{R^0\bar{T}_s}\right)\left[1 - \frac{\bar{P}\exp\left(\frac{q}{R_0\bar{T}_s}\right)}{B_1\left(1+\frac{G}{1-G}\frac{W_{AP(g)}}{W_G}\right)}\right]$$

we obtain:

$$1 + \frac{m'}{\bar{m}} = \exp\left(\frac{E_{0x}}{R^0\bar{T}_s}\cdot\frac{T_s'}{\bar{T}_s}\right)\frac{C + 1 - \left(1+\frac{P'}{\bar{P}}\right)\exp\left[\frac{-q}{R^0\bar{T}_s}\cdot\frac{T_s'}{\bar{T}_s}\right]}{C} \tag{12}$$

where

$$C \equiv \frac{B_1\left(1+\frac{G}{1-G}\frac{W_{AP(g)}}{W_G}\right)}{\bar{P}\exp\left(\frac{q}{R^0\bar{T}_s}\right)} - 1$$

Since $\frac{E_{0x}}{R^0\bar{T}_s}\cdot\frac{T_s'}{\bar{T}_s}$ and $\frac{q}{R^0\bar{T}_s}\cdot\frac{T_s'}{\bar{T}_s}$ are both very small ($\frac{E_{0x}}{R^0\bar{T}_s}$ and $\frac{q}{R^0\bar{T}_s}$ are of the order of 10, while $\frac{T_S'}{\bar{T}_S}$ is of the order of $10^{-3}\sim 10^{-2}$), we can write

$$\exp\left(\frac{E_{0x}}{R^0\bar{T}_s}\cdot\frac{T_s'}{\bar{T}_s}\right) \approx 1 + \frac{E_{0x}}{R^0\bar{T}_s}\cdot\frac{T_s'}{\bar{T}_s}$$

$$\exp\left(\frac{-q}{R^0\bar{T}_s}\cdot\frac{T'}{\bar{T}_s}\right) \approx 1 - \frac{q}{R^0\bar{T}_s}\cdot\frac{T_s'}{\bar{T}_s}$$

Substituting into equation (12) and neglecting higher-order terms, we get:

$$\frac{m'}{\bar{m}} = \frac{E_{0x}}{R^0\bar{T}_s}\cdot\frac{T_s'}{\bar{T}_s} - \frac{\frac{P'}{\bar{P}} - \frac{q}{R^0\bar{T}_s}\frac{T_s'}{\bar{T}_s}}{C}$$

As before, since the equation should hold at any time t, we have:

$$\frac{\tilde{m}}{\bar{m}}=\frac{E_{0x}}{R^0\bar{T}_s}\left[\frac{C+\frac{q}{E_{0x}}}{C}\frac{\tilde{T}_s}{\bar{T}_s}-\frac{R^0\bar{T}_s}{CE_{0x}}\frac{\tilde{p}}{\bar{p}}\right] \tag{13}$$

3) Applying a similar linearization procedure to equation (3) gives:

$$\frac{\tilde{T}_f}{\bar{T}_f}=\frac{\frac{\tilde{m}}{\bar{m}}-n\frac{\tilde{p}}{\bar{p}}}{\frac{E_f}{2R^0\bar{T}_f}} \tag{14}$$

4) Similarly, equation (4) can be reduced to:

$$\left(\frac{d\tilde{T}}{d\xi}\right)_s+(\tilde{T}_f-\tilde{T}_s)=\frac{\tilde{m}}{\bar{m}}\left(\frac{d\bar{T}}{d\xi}\right)_s \tag{15}$$

(C) Solution of the Equation

In view of equation (9) and its boundary conditions

$$\frac{d^2\tilde{T}}{d\xi^2}-\frac{d\tilde{T}}{d\xi}=0$$

$$\begin{cases}\xi=-\infty\text{时}\tilde{T}=T_i\\ \xi=0\quad\text{时}\tilde{T}=\tilde{T}_s\end{cases}$$

it is clear that the solution is of the form $\tilde{T}=T_i+(\tilde{T}_s-T_i)e^{\xi}$, thus, $\frac{d\tilde{T}}{d\xi}=(\tilde{T}_s-T_i)e^{\xi}$. Substituting this expression into equation (15), we get:

$$\left(\frac{d\tilde{T}}{d\xi}\right)_s=-\left(\tilde{T}_f-\tilde{T}_s\right)+\tilde{T}_s\left(1-\frac{T_i}{\bar{T}_s}\right)\frac{\tilde{m}}{\bar{m}} \tag{16}$$

Upon substitution of equations (10) and (13), equation (10) becomes

$$\frac{d^2\tilde{T}}{d\xi^2}-\frac{d\tilde{T}}{d\xi}-S\tilde{T}=\frac{E_{0x}}{R^0}\left(1-\frac{T_i}{\bar{T}_s}\right)\left[\left(\frac{C+\frac{q}{E_{0x}}}{C}\right)\frac{\tilde{T}_s}{\bar{T}_s}-\frac{R^0\bar{T}_s}{CE_{0x}}\frac{\tilde{p}}{\bar{p}}\right]e^{\xi}$$

with boundary conditions: $\tilde{T} = 0$ when $\xi = -\infty$,
$\tilde{T} = \tilde{T}_s$ when $\xi = 0$.

Therefore, the general solution of the equation is:

$$\tilde{T}=c'e^{\lambda\xi}-\frac{A}{S}\left[\frac{C+\frac{q}{E_{0x}}}{C}-\frac{\tilde{T}_s}{\bar{T}_s}\frac{R^0\bar{T}_s}{CE_{0x}}\frac{\tilde{p}}{\bar{p}}\right]\tilde{T}_s e^{\xi}$$

where $A \equiv \frac{E_{0x}}{R^0 T_s}\left(1-\frac{T_i}{T_s}\right)$, and λ is determined from the characteristic equation $\lambda^2 - \lambda - S = 0$. Since $\widetilde{T} = 0$ when $\xi = -\infty$, the only admissible characteristic root is $\lambda = (1 + \sqrt{1 + 4S})/2$. Also, from the boundary condition $\widetilde{T} = \widetilde{T}_s$ when $\xi = 0$, we can obtain the solution as follows:

$$\bar{T} = \bar{T}_s\left[e^{\lambda t} + \frac{A}{S}\left(\frac{C+\frac{q}{E_{0x}}}{C} - \frac{\bar{T}_s}{\bar{T}_s}\,\frac{R^0 T_s}{C E_{0x}}\,\frac{\bar{p}}{\bar{p}}\right)(e^{\lambda t} - e^{t})\right]$$

Substituting into equation (16), we get:

$$\lambda + \frac{A}{S}\left(\frac{C+\frac{q}{E_{0x}}}{C} - \frac{\bar{T}_s}{\bar{T}_s}\,\frac{R^0 T_s}{C E_{0x}}\,\frac{\bar{p}}{\bar{p}}\right)(\lambda - 1)$$

$$= \left(1-\frac{T_i}{T_s}\right)\left(\frac{\bar{T}_s}{\bar{T}_s}\right)^{-1}\frac{\bar{m}}{\bar{m}} - \left[\frac{\bar{T}_f}{\bar{T}_f}\cdot\frac{\bar{T}_f}{\bar{T}_s}\cdot\left(\frac{\bar{T}_s}{\bar{T}_s}\right)^{-1} - 1\right] \qquad (17)$$

From equation (13),

$$\left(\frac{\bar{T}_s}{\bar{T}_s}\right)^{-1} = \frac{E_{0x}}{R^0 \bar{T}_s}\cdot\frac{C+\frac{q}{E_{0x}}}{C\frac{\bar{m}}{\bar{m}} + \frac{\bar{p}}{\bar{p}}} \qquad (18)$$

Substituting equations (14) and (18) into equation (17), we get:

$$\lambda + \frac{A}{S}\left(\frac{C+\frac{q}{E_{0x}}}{C} - \frac{\frac{\bar{p}}{\bar{p}}}{C}\cdot\frac{C+\frac{q}{E_{0x}}}{C\frac{\bar{m}}{\bar{m}} + \frac{\bar{p}}{\bar{p}}}\right)(\lambda - 1)$$

$$= A\frac{\bar{m}}{\bar{m}}\cdot\frac{C+\frac{q}{E_{0x}}}{C\frac{\bar{m}}{\bar{m}} + \frac{\bar{p}}{\bar{p}}} - \left[\frac{\frac{\bar{m}}{\bar{m}} - n\frac{\bar{p}}{\bar{p}}}{\frac{E_f}{2R^0 T_f}}\cdot\frac{\bar{T}_f}{\bar{T}_s}\cdot\frac{\frac{C+\frac{q}{E_{0x}}}{C\frac{\bar{m}}{\bar{m}} + \frac{\bar{p}}{\bar{p}}}}{\frac{R^0 T_s}{E_{0x}}} - 1\right]$$

Let $B \equiv \frac{2R^0 T_f^2}{(T_s - T_i)E_f}$, then from the definition of pressure response function $R_p \equiv \frac{\bar{m}}{\bar{m}}\Big/\frac{\bar{p}}{\bar{p}}$ the above equation can be arranged to yield:

$$R_p' = \frac{nAB - \frac{\lambda - 1}{C + q/E_{0x}}}{\frac{A}{\lambda} - A + AB + \frac{C}{C + q/E_{0x}}(\lambda - 1)}$$

Region II:

By following a similar procedure as above, with the exception that equation (2) is changed to $m=A_{0x}\exp\left(-\frac{E_{0x}}{R^0T_s}\right)$, we can derive an expression for the pressure response function for region II:[5]

$$R_p^{II}=\frac{nAB}{\frac{A}{\lambda}-A+AB+(\lambda-1)}$$

Then, by using the conventional assumption that the burning surface gain is proportional to its area, the pressure response function of the entire burning surface which contains both region I and region II should be:

$$R_p=\gamma\frac{n_IA_IB_I-\frac{\lambda-1}{C+q/E_{0x}}}{\frac{A_I}{\lambda}-A_I+A_IB_I+\frac{C}{C+q/E_{0x}}(\lambda-1)}+(1-\gamma)\frac{n_{II}A_{II}B_{II}}{\frac{A_{II}}{\lambda}-A_{II}+A_{II}B_{II}+(\lambda-1)}$$

Its real and imaginary parts are respectively:

$$(R_p)_r=\gamma\frac{\lambda_rn_IA_IB_ID+\left(\lambda_in_IA_IB_I-\frac{\Omega}{C+q/E_{0x}}\right)E}{D^2+E^2}+(1-\gamma)\frac{n_{II}A_{II}B_{II}(\lambda_rD+\lambda_iF)}{D^2+F^2}$$

$$(R_p)_i=\gamma\frac{-\lambda_rn_IA_IB_IE+\left(\lambda_in_IA_IB_I-\frac{\Omega}{C+q/E_{0x}}\right)D}{D^2+E^2}+(1-\gamma)\frac{n_{II}A_{II}B_{II}(\lambda_iD-\lambda_rF)}{D^2+F^2}$$

where $D\equiv A+\lambda_r(AB-A)$, $E\equiv\frac{C}{C+q/E_{0x}}\Omega+\lambda_i(AB-A)$,

$F\equiv\Omega+\lambda_i(AB-A)$;

$$\lambda_r=\frac{1}{2}\left\{1+\sqrt{\frac{1}{2}\left[1+(1+16\Omega^2)^{\frac{1}{2}}\right]^{\frac{1}{2}}}\right\}$$

$$\lambda_i=\frac{1}{2}\sqrt{\frac{1}{2}\left[-1+(1+16\Omega^2)^{\frac{1}{2}}\right]^{\frac{1}{2}}}$$

IV. Results and Discussion

Table 1 presents some preliminary calculated results obtained by applying the steady-state model[1] to the S04-5A propellant; these results provide the initial data which are substituted into the real part of the pressure response function to produce the results shown in Figure 3.

Table 1. Initial Data

Parameter	Unit	Numerical value	Parameter	Unit	Example 1	Example 2
B_1	kg/cm²	3.48×10^8	P	kg/cm²	23	35
C	Cal/g·°K	0.3	G		0.3	0.2
E_{s_2}	Cal/mole	2.2×10^4	γ		0.6	0.8
E_f	Cal/mole	6.0×10^4	n		0.572	−0.693
q	Cal/mole	2.08×10^4	T_{s1}	°K	1038.6	1098.8
T_f	°K	2900	n_1		0.75	−0.783
T_i	°K	293	T_{s11}	°K	1086.6	1108.0
$W_{AP(g)}$	g/mole	117.5	n_{11}		0.486	0.424
W_G	g/mole	28.4				
λ	Cal/cm·sec·°K	0.3×10^{-3}				
ρ	g/cm³	1.665				

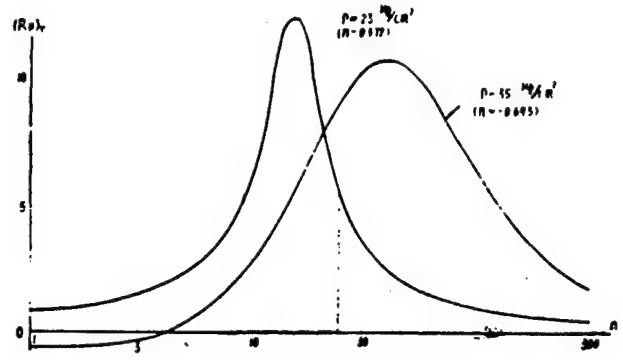

Figure 3. Real Part of the Pressure Response Function for the S04-5A Propellant Under Two Different Pressure Conditions

Both the formula and the calculated results show that for the "plateau" and the "mesa" propellants with zero or negative pressure exponents, the real part of the pressure response function can be greater than zero over a wide range of frequencies. This provides a theoretical verification of the phenomena of combustion instability (sometimes severe instability) in both types of propellants.[4, 6-8] Furthermore, as predicted by this author in Reference 1, if local extinction is replaced by the abnormal burning of oxidizer covered by the

molten binder, it is likely for self-excited oscillations to occur under pressure conditions that lead to large area coverage; this provides a logical explanation of the experimental observations. The dashed line in Figure 3 represents the "T" engine test reported in Reference 1, where self-excited oscillations of the propellant occurred under a pressure of $P = 23 kg/cm^2$, which resulted in wide area coverage. The corresponding frequency will yield a relatively large value of the real part of the pressure response function; hence it was no surprise that self-excited oscillations were present during the test.

The above results were obtained from a region I analysis using our steady-state model and taking into consideration the coverage of oxidizer surface by molten binder and the presence of condensed-phase reaction and reverse gasification. Therefore, the derived theoretical formula not only has overcome the difficulty of previous formulas which could not be applied to propellants with negative pressure exponents, but also has illustrated the robustness of the steady-state combustion model[1] which exhibits burning speed characteristics with both positive and negative pressure exponents.

In the case where the fractional area coverage ν is zero, the formula reduces to the "two-parameter" formula for propellants with infusible binder:

$$R_P = \frac{nAB}{\lambda + \frac{A}{\lambda} - (1+A) + AB}$$

which is the previously derived general expression for "one-dimensional model of gas-phase quasi-steady uniform propellant."[2] Therefore, the formula derived in this article may have a much wider range of applications.

In deriving the formula, we have made a number of unrealistic assumptions. For example: (a) the assumption of an infinitesimally thin condensed-phase layer where condensed-phase reaction and gasification take place is not a good approximation[2]; (b) the assumption of gas-phase quasi-steady-state is accurate to within 10 percent only when the frequency is less than 10^4 Hz[2,5]; (c) the compressibility of propellant can produce an effect of less than 10 percent on the response function[9]; (d) under certain conditions, thermal radiation loss has a pronounced effect on the response function[10,11]; (e) in our steady-state model, the condensed-phase reaction should be a function of pressure,[1] but for mathematical simplicity, its response to pressure disturbance is neglected, which will undoubtedly introduce certain errors. With the exception of the question on condensed-phase reaction, the assumptions listed above are still being used by most investigators in the literature; nevertheless, this points out that the formula derived in this article can be further improved.

Clearly, the formula derived under the assumption of uniform mass can only be used under such conditions. However, the nonuniformity of propellant has been simulated by some authors[12] using the following method. A multimode composite propellant is treated as a randomly arranged "surface pairs" of multiple dispersion oxidizer particles and fuels; when each "pair" is assumed to be independent, the propellant surface can be rearranged as a family of virtual single-dispersion propellants, i.e., the so-called hypothetical propellant. The

pressure responses of these hypothetical propellants are calculated using a formula derived from the uniform-mass theory, and the pressure response of the entire composite propellant is readily obtained. As pointed out in Reference 3, despite its disadvantage of using two different models, this method is still being pursued. Therefore, the assumption of uniform mass does not invalidate the present model in describing the problem of pressure coupling of composite solid propellants.

V. Conclusions

1) A new formula for the pressure response function has been derived using a steady-state combustion model which is valid for solid propellant with positive or negative pressure exponent burning speed characteristics. This formula provides a logical explanation of the phenomena of combustion instability in solid propellants with positive, negative, or zero pressure exponents.

2) As in the case of modeling steady-state combustion, the phenomenon of oxidizer surface covered by molten binder should be taken into consideration in modeling the unstable combustion of solid propellants.

3) The assertion of replacing local extinction by the abnormal burning of oxidizer covered by molten binder which involves condensed-phase reaction and reverse gasification is correct and necessary. This is true not only under steady-state conditions but also under nonsteady-state conditions.

4) The model proposed in this article should be further verified and improved.

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APPLIED SCIENCES

ONE-DIMENSIONAL TWO-PHASE FLOW IN COMBUSTION CHAMBER OF SOLID PROPELLANT ROCKET MOTORS

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[Article by Chang Xianqi [1603 7359 1142]]

[Text] Nomenclature

A -- channel cross-sectional area

A_b -- propellant combustion area

A_Q -- conversion factor between work and heat

A_t -- nozzle throat area

$\overline{M}$ -- average molecular weight of gas

n -- pressure exponent

P -- pressure

P_s -- total pressure

b -- speed of combustion coefficient

C^* -- propellant characteristic speed

C_1 -- particle specific heat

C_{pg} -- constant-pressure specific heat of gas phase

g -- gravitational acceleration

h -- enthalpy of unit mass

H_s -- total enthalpy of 1 kg of two-phase mixture

H_{sg} -- total enthalpy of 1 kg of gas phase

H_{sp} -- total enthalpy of 1 kg of condensed phase

k -- ratio of specific heat of gas phase

K -- particle velocity lab number

K_1 -- area to throat ratio, $K_1 = A_b/A_t$

Nomenclature [continued]

ℓ -- length of loaded propellant

L -- particle temperature lag number

$\dot{m}$ -- mass flow rate of two-phase mixture

$\dot{m}_g$ -- mass flow rate of gas phase

q -- heat flow of unit mass particle

r -- combustion speed

r_p -- particle radius

R_g -- gas constant of gas phase

S -- channel circumference

t -- time

T -- temperature

T_0 -- total temperature of gas phase at propellant head section

T_s -- total temperature of gas phase

v -- flow velocity

x -- axial coordinate

X -- drag of a unit-mass particle

y_c -- outer radius of loaded propellant

ρ -- density

ρ_T -- density of propellant

$\dot{m}_p$ -- mass flow rate of condensed phase

M_g -- Mach number of gas phase

ρ_{mP} -- density of Al_2O_3

ε -- fraction of particle mass flow rate, $\varepsilon = \dot{m}_p/\dot{m}$

λ_g -- coefficient of heat conduction of gas phase

μ_g -- dynamic viscosity coefficient of gas phase

Subscript

g -- gas phase

0 -- propellant head section

t -- nozzle throat section

P -- condensed phase

L -- propellant tail section

i -- initial value

I. Introduction

In order to increase the energy of today's composite solid propellant and to eliminate combustion instability, aluminum powder is added to the propellant. During combustion, the aluminum will cause the formation of condensed Al_2O_3 particles which may account for 30-40 percent of the total weight. Therefore, the product of combustion flowing in the combustion chamber and the nozzle is actually a two-phase mixture of gas and liquid.

A great deal of work has been done to study the problem of two-phase flow in nozzles of solid propellant rocket motors; in particular, significant results have been obtained from the studies of one-dimensional two-phase flow and two-dimensional axial-symmetric two-phase flow. The two-phase flow in combustion chamber has some unique characteristics because of the constant addition of mass. The author has studied the one-dimensional two-phase constant lag flow in combustion chamber, and has analyzed the effect of particle velocity lag on the performance of combustion chamber. This article addresses the problem of two-phase nonequilibrium flow in combustion chambers. Based on the equation of one-dimensional two-phase flow with mass addition, a detailed numerical solution of the basic equations is presented. The effect of particle size on the flow filed inside the combustion chamber and the pressure-time curve is analyzed, and some interesting conclusions are obtained by comparing with the results of constant lag flow. These results provide a more accurate prediction of the pressure-time curve and more accurate boundary conditions for calculating two-phase nozzle flow.

II. Basic Equations

Assumptions:

1. The flow is one-dimensional and pseudostationary;

2. The effects of friction and heat transfer along the channel wall are neglected;

3. The Al_2O_3 particles are spherical, uniform in size, and in liquid state; the volume of the particle and the effect on pressure due to Brownian motion are neglected;

4. For the gas phase, an ideal gas with frozen constituents are assumed, viscous effects are neglected except where it is in contact with the particles;

5. There is no mass transfer between the two phases;

6. Both the gas and the particles have constant specific heat.

With the above assumptions, the basic equations for two-phase flow in a combustion chamber can be derived:

Gas Phase

Mass equation

$$\frac{d}{dx}(\rho_g v_g A)=(1-\varepsilon)\rho_T r S \tag{1}$$

Momentum equation

$$\frac{d}{dx}(\rho_g v_g^2 A)=-A\frac{dP}{dx}-X\rho_P A \tag{2}$$

Energy equation

$$\frac{d}{dx}\left[\rho_g g v_g A\left(h_g+A_Q\frac{v_g^2}{2g}\right)\right]=(1-\varepsilon)\rho_T r S g H_{Sg}-A_Q X\rho_P v_P A+q\rho_P A \tag{3}$$

where

$$r=bP^n$$

$$h_g=C_{Pg}T_g$$

Condensed phase

Mass equation

$$\frac{d}{dx}(\rho_P v_P A)=\varepsilon\rho_T r S \tag{4}$$

Momentum equation

$$\frac{d}{dx}(\rho_P v_P^2 A)=X\rho_P A \tag{5}$$

Energy equation

$$\frac{d}{dx}\left[\rho_P g v_P A\left(h_P+A_Q\frac{v_P^2}{2g}\right)\right]=\varepsilon\rho_T r S g H_{SP}+A_Q X\rho_P v_P A-q\rho_P A \tag{6}$$

Two Phase Mixture

Mass equation

$$\frac{d\dot{m}}{dx}=\rho_T r S \tag{7}$$

Momentum equation

$$\frac{d}{dx}(\rho_g v_g^2 A+\rho_P v_P^2 A)=-A\frac{dP}{dx} \tag{8}$$

Energy equation

$$\frac{d}{dx}\left[\dot{m}_g\left(h_g+A_Q\frac{v_g^2}{2g}\right)+\dot{m}_P\left(h_P+A_Q\frac{v_P^2}{2g}\right)\right]=\rho_T r S H_S \tag{9}$$

where

$$\dot{m}_g=\rho_g v_g A$$

$$\dot{m}_P=\rho_P v_P A$$

$$\dot{m}=\dot{m}_g+\dot{m}_P$$

III. Supplementary Relations

Since equations (1)-(6) are incomplete, it is necessary to introduce the following supplementary relations.

1. Gas phase equation of state

For an ideal gas, $$P=\rho_g g R_g T_g \tag{10}$$

2. Condensed phase equation of state

When the temperature of the Al_2O_3 particle is higher than its melting point (T_{Pm} = 2318°K), then assuming constant specific heat, we have

$$h_P=h_{Pm}+C_l(T_P-T_{Pm}) \tag{11}$$

where C_1 is the specific heat of liquid Al_2O_3 particles, equal to 0.34327 kcal/kg·deg

h_{Pm} is the enthalpy of liquid Al_2O_3 particles at T_{Pm}, equal to 876.9498 kcal/kg.

From equation (11) we have

$$dh_P=C_l dT_P \tag{12}$$

3. The drag of a unit-mass particle is

$$X=A_P(v_g-v_P) \tag{13}$$

Under the conditions inside the combustion chamber, the particles remain in the state of Stokes flow, thus

$$A_P=\frac{9}{2}\frac{\mu_g}{r_P^2\rho_{mP}}$$

where $\mu_g = 1.208 \times 10^{-8}\ T_g^{0.6}\ \overline{M}^{0.5}$ kg·sec/m^2.

4. The heat flow of a particle with unit mass is

$$q=B_P(T_P-T_g) \tag{14}$$

where $$B_P=\frac{3\lambda_g}{r_P^2\rho_{mP}}$$

5. The total enthalpy of 1 kg of a two-phase mixture is

$$H_S=(1-\varepsilon)H_{Sg}+\varepsilon H_{SP}$$

According to assumption 2, H_S does not vary along the length of the channel; thus, H_S can be expressed in terms of the parameters at the propellant head section (x=0) ($v_g = v_P = 0$, $T_g = T_P = T_0$):

$$H_S=(1-\varepsilon)C_{Pg}T_0+\varepsilon[h_{Pm}+C_l(T_0-T_{Pm})] \tag{15}$$

IV. Computational Equations

Let

$$K\equiv\frac{v_P}{v_g} \qquad (0\leqslant K\leqslant 1) \tag{16}$$

$$L\equiv\frac{T_0-T_P}{T_0-T_g} \qquad (0\leqslant L\leqslant 1) \tag{17}$$

then the particle velocity lag = $\dfrac{v_g-v_P}{v_g}=1-K$

and the particle temperature lag = $\dfrac{T_P-T_g}{T_0-T_g}=1-L$

K and L are respectively called the velocity lag number and temperature lag number of the particle.

Neglecting the effect of corrosive combustion and assuming no axial variation in the channel cross sectional area A, then by introducing a number of transformations, a set of computational equations can be derived from the basic equations for numerical calculations.

$$
\begin{aligned}
&\frac{dv_P}{dx} = A_P\frac{v_g - v_P}{v_P} - \frac{\varepsilon\rho_T r S}{\rho_P A}\\
&\frac{dv_g}{dx} = -\frac{R_g}{\rho_g(v_g^2 C_{Pg} - gR_g T_g C_{Pg} - A_Q R_g v_g^2)}\Big[g\rho_P h_g A_P\frac{v_g - v_P}{v_g}\\
&\qquad + \rho_P B_P(T_P - T_g) + A_Q\rho_P A_P(v_g - v_P)^2 + (1-\varepsilon)\rho_T r\frac{S}{A}g\\
&\qquad \cdot\left(H_{Sg} + h_g + A_Q\frac{v_g^2}{2g}\right)\Big] - \frac{(1-\varepsilon)\rho_T r S}{\rho_g A} - \frac{\varepsilon}{1-\varepsilon}A_P\frac{v_g - v_P}{v_P}\\
&\frac{dm}{dx} = \rho_T r S\\
&\rho_P = \frac{\varepsilon m}{v_P A}\\
&\rho_g = \frac{(1-\varepsilon)m}{v_g A}\\
&P = P_0 - (\rho_g v_g^2 + \rho_P v_P^2)\\
&T_g = \frac{P}{\rho_g g R_g}\\
&T_P = \frac{1}{\varepsilon C_l}\Big[\varepsilon C_l T_0 + (1-\varepsilon)C_{Pg}T_0 - (1-\varepsilon)C_{Pg}T_g\\
&\qquad -(1-\varepsilon)A_Q\frac{v_g^2}{2g} - \varepsilon A_Q\frac{v_P^2}{2g}\Big]\\
&M_g = \frac{v_g}{\sqrt{kgR_g T_g}}\\
&T_S = T_g\left(1 + \frac{k-1}{2}M_g^2\right)\\
&P_S = P\left(1 + \frac{k-1}{2}M_g^2\right)^{\frac{k}{k-1}}
\end{aligned}
\qquad (18)
$$

where $H_{Sg} = C_{Pg}T_S$

The set of computational equations (18) consist of 3 differential equations and 8 algebraic equations with unknown v_P, T_P, ρ_P, v_g, T_g, ρ_g, P, P_S, T_S, M_g and $\dot{m}$; for a given set of boundary conditions, they can be solved by using the 4th order Runge-Kutta method.

V. Initial Conditions and Boundary Conditions

Initial Conditions

At t=0, $S=S_i$, $A=A_{iO}$. The values of S_i, A_i can be determined by the actual shape of the propellant channel; for a circular channel,

$$
\begin{aligned}
S_i &= 2\pi y_i\\
A_i &= \pi y_i^2
\end{aligned}
$$

where y_i is the initial radius of the channel.

Boundary Conditions

The boundary conditions for an interior-hole combustion type propellant packet which is pour-cast along the channel wall and covered at both ends are as follows (See Figure 1):

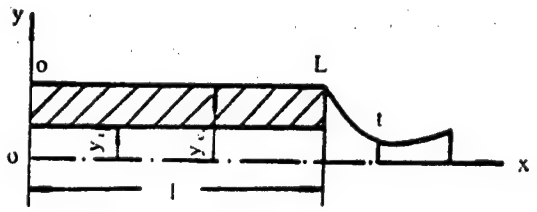

Figure 1

At the propellant head section (x=0)

$$\left.\begin{aligned} &v_{P0}=v_{g0}=0\\ &\dot{m}_0=0\\ &T_{g0}=T_{P0}=T_0\\ &P=P_0\\ &\rho_{g0}=\frac{P_0}{gR_gT_0}\\ &\rho_{P0}=\frac{\varepsilon}{1-\varepsilon}\frac{v_{g0}}{v_{P0}}\rho_{g0}=\frac{\varepsilon}{1-\varepsilon}\frac{\rho_{g0}}{K_0} \end{aligned}\right\} \tag{19}$$

where the gas-phase total temperature of the propellant head section T_0 is equal to the combustion temperature of the propellant. P_0 is the pressure of the head section which must be determined by iteration from the flow rate as part of the numerical solution. The particle density at the head section ρ_{P0} is undefined (=0/0); it must be determined by finding the value of K_0.

At the propellant tail section (x=ℓ)

The mass flow rate of the two-phase mixture at the propellant tail section should be equal to the flow rate at the nozzle throat section, i.e.,

$$\dot{m}_L=\dot{m}_t \tag{20}$$

$\dot{m}_L$ can be determined from the flow parameters at x=ℓ, i.e.,

$$\dot{m}_L=A(\rho_{gL}v_{gL}+\rho_{PL}v_{PL}) \tag{21}$$

Since the primary interest of this article is to study the two-phase nonequilibrium flow in the combustion chamber, we determine the boundary conditions for the propellant tail section by assuming one-dimensional two-phase lag flow in the nozzle, so that a numerical solution of the one-dimensional two-phase nonequilibrium flow for the nozzle can be avoided. Thus,

Since the primary interest of this article is to study the two-phase nonequilibrium flow in the combustion chamber, we determine the boundary conditions for the propellant tail section by assuming one-dimensional two-phase lag flow in the nozzle, so that a numerical solution of the one-dimensional two-phase nonequilibrium flow for the nozzle can be avoided. Thus,

$$\dot{m}_t=\frac{1}{1-\varepsilon}\frac{\bar{\Gamma}}{\sqrt{gR_gT_0C}}P_{SL}A_t\sqrt{\frac{k}{\bar{r}}} \tag{22}$$

where $C=1+\frac{\varepsilon}{1-\varepsilon}\{K[k(1-K)+K]+(k-1)\delta LD\}$

$$D=\frac{1+\frac{\varepsilon}{1-\varepsilon}K^2}{1+\frac{\varepsilon}{1-\varepsilon}\delta L}$$

$$\delta=\frac{C_l}{C_{Pg}}$$

$$\bar{r}=1+(k-1)\frac{D}{C}$$

$$\bar{\Gamma}=\sqrt{\bar{r}}\left(\frac{2}{\bar{r}+1}\right)^{\frac{\bar{r}+1}{2(\bar{r}-1)}}$$

Here, the values of K and L correspond to conditions at the propellant tail section.

VI. Determination of K_0, L_0

In order to determine the distributions of particle velocity lag and temperature lag along the channel length, and to provide the necessary boundary conditions for solving equation set (18), the value of K and L at the propellant head section (x=0) must be determined. Since both K and L are undefined at x=0, we introduce the definitions

$$K_0=K_{x\to0^+}$$
$$L_0=L_{x\to0^+}$$

1. Determination of K_0

From l'Hospital's rule

$$K_0=\frac{v_p'|_{x\to0^+}}{v_g'|_{x\to0^+}} \tag{a}$$

A slight modification of the first equation of (18) shows that when $x\to0^+$, $v_p'\big|_{x\to0^+}$ is also undefined (=0/0). Therefore,

$$v'_P|_{x\to 0^+} = A_P \frac{v'_g|_{x\to 0^+} - v'_P|_{x\to 0^+}}{v'_P|_{x\to 0^+}} - v'_P|_{x\to 0^+}$$

For convenience, we shall omit the subscript $x\to 0^+$; after some rearrangement, this equation becomes

$$\frac{2}{A_P} v'^2_P + v'_P - v'_g = 0 \tag{b}$$

By using the boundary condition (19), one can derive from the second equation of (18) that when $x\to 0^+$,

$$v'_g = \frac{(1-\varepsilon)\rho_T r_0 S}{\rho_{g0} A} \tag{c}$$

where $r_0 = bP_0^n$

Substituting (c) into (b) and solving for v'_P when $x\to 0^+$, we obtain

$$v'_P = \frac{-1 \pm \sqrt{1 + \frac{8}{A_P} \frac{(1-\varepsilon)\rho_T r_0 S}{\rho_{g0} A}}}{\frac{4}{A_P}} \tag{d}$$

Since the flow in the combustion chamber involves mass addition, the particle velocity v_P increases, $v'_P > 0$, hence a "+" sign should be chosen in front of the radical in equation (d). Substituting equations (c), (d) into equation (a) and letting

$$\alpha = \frac{4}{A_P} \frac{(1-\varepsilon)\rho_T r_0 S}{\rho_{g0} A} \tag{23}$$

we obtain

$$K_0 = \frac{-1 + \sqrt{1+2\alpha}}{\alpha} \tag{24}$$

2. Determination of L_0

Again applying 1'Hospital's rule

$$L_0 = \frac{T'_P|_{x\to 0^+}}{T'_g|_{x\to 0^+}} \tag{e}$$

one can derive from the basic equations (1)-(6)

$$\frac{dT_P}{dx} = T'_P = \frac{1}{xC_l}\left(H_{SP} - h_P + A_Q \frac{v_P^2}{2g}\right) - \frac{B_P(T_P - T_g)}{v_P g C_l}$$

This shows that $T_p'|_{x\to 0+}$ is also undefined (=0/0). From l'Hospital's rule, one obtains the following

$$T_p'|_{x\to 0^+} = -T_p'|_{x\to 0^+} - \frac{B_p}{gC_l}\,\frac{T_p'|_{x\to 0^+} - T_g'|_{x\to 0^+}}{v_p'|_{x\to 0^+}}$$

Again omitting the subscript $x\to 0^+$, we get

$$2T_p' = -\frac{B_p}{gC_l}\,\frac{T_p' - T_g'}{v_p'} \tag{f}$$

Let

$$\beta = \frac{B_p}{gC_l}\,\frac{1}{v_p'}$$

then from equation (f) we get

$$L_0 = \frac{\beta}{2+\beta} \tag{25}$$

Taking into consideration equations (d) and (23), we obtain:

$$\beta = \frac{4}{gC_l}\,\frac{B_p}{A_p}\,\frac{1}{(-1+\sqrt{1+2a})} \tag{26}$$

VII. Numerical Solution of the Equation Set (18)

Under the boundary conditions (19), (20) and the given initial conditions, the equation set (18) can be solved using 4th order Runge-Kutta method to obtain the following:

1. The distribution of gas phase flow parameters (v_g, T_g, ρ_g, P, P_S, T_S, M_g), particle flow parameters (v_p, T_p, ρ_p), and the particle lag numbers K and L along the channel at any given time;

2. The time variation of combustion chamber pressure.

In the boundary condition (19), the head pressure P_0 is unknown and must be determined as part of the numerical solution. The procedure is as follows.

(1) A first order approximation of the head pressure is obtained from

$$P_0^{(1)} = (C^*\rho_T b K_1)^{\frac{1}{1-n}}$$

(2) The equation set (18) is solved under $P_0^{(1)}$ to yield the distribution of gas phase and particle parameters along x, and $\dot{m}_L$ and $\dot{m}_t$ are calculated from equations (21) and (22).

(3) Let $\dot{m} = \dot{m}_t - \dot{m}_L$, test to see if the following condition holds

$$\left|\frac{\Delta \dot{m}}{\dot{m}_t}\right| \leqslant \varepsilon_1 \tag{27}$$

(ε_1 is the specified tolerance);

(4) If condition (27) is not satisfied, then $\Delta\dot{m} > 0$, let $P_0^{(2)} = P_0^{(1)} - \Delta P$ (ΔP is the specified pressure increment, e.g., $\Delta P = 1$ kg/cm^2). Otherwise let $P_0^{(2)} = P_0^{(1)} + \Delta P$, and the solution of equation (18) is repeated; if the flow rate satisfies (27), then $P_0^{(2)}$ is the actual head pressure P_0.

(5) If the condition (27) is still not satisfied, then the following recursive formula is used to calculate $P_0^{(n)}$:

$$P_0^{(n)} = P_0^{(n-1)} + \Delta \dot{m}^{(n-1)} \frac{P_0^{(n-1)} - P_0^{(n-2)}}{\Delta \dot{m}^{(n-2)} - \Delta \dot{m}^{(n-1)}} \qquad (n=3,4,5,\cdots\cdots)$$

and the solution of equation (18) is repeated until (27) is satisfied. Figure 2 shows the flow diagram of the numerical procedure; r_{CP} is the average speed of combustion along the channel length.

VIII. Effect of Particle Size on Interior Trajectory Characteristics

Calculations of the pressure-time history and the flow field in the combustion chamber have been performed for different particle sizes for a particular solid propellant engine (ε = 0.26).

Figure 3 shows the effect of particle size on the pressure-time curve; specifically, it shows that the combustion chamber pressure decreases with increasing particle size. At t=0 sec, the variation of pressure with particle radius is shown in Figure 4. The drop in combustion chamber pressure will reduce the burning speed, increase burning time, and also cause the flow rate to decrease.

Figure 5 shows the distribution of various gas phase parameters along x for different particle sizes at t=0 sec. M_g increases along the length whereas other parameters decrease. Since P_0 decreases with increasing particle size, the parameters P, P_S, ρ_g all vary inversely with particle size. But particle size has little effect on T_g.

Figure 6 shows the distribution of gas phase velocity v_g and particle velocity v_P along the channel for different particle sizes. Since the flow in the combustion chamber involves mass addition, both v_g and v_P increase along the channel. But the particle size has opposite effects on v_g and v_P; as particle size increases, v_g increases but v_P decreases. This is because the drag of a unit-mass particle varies as $X \propto 1/r_P^2$; the larger the particle size, the smaller the drag, and the larger the gas phase velocity. Also, the particle acceleration due to force imparted by the gas phase is smaller, hence v_P is smaller.

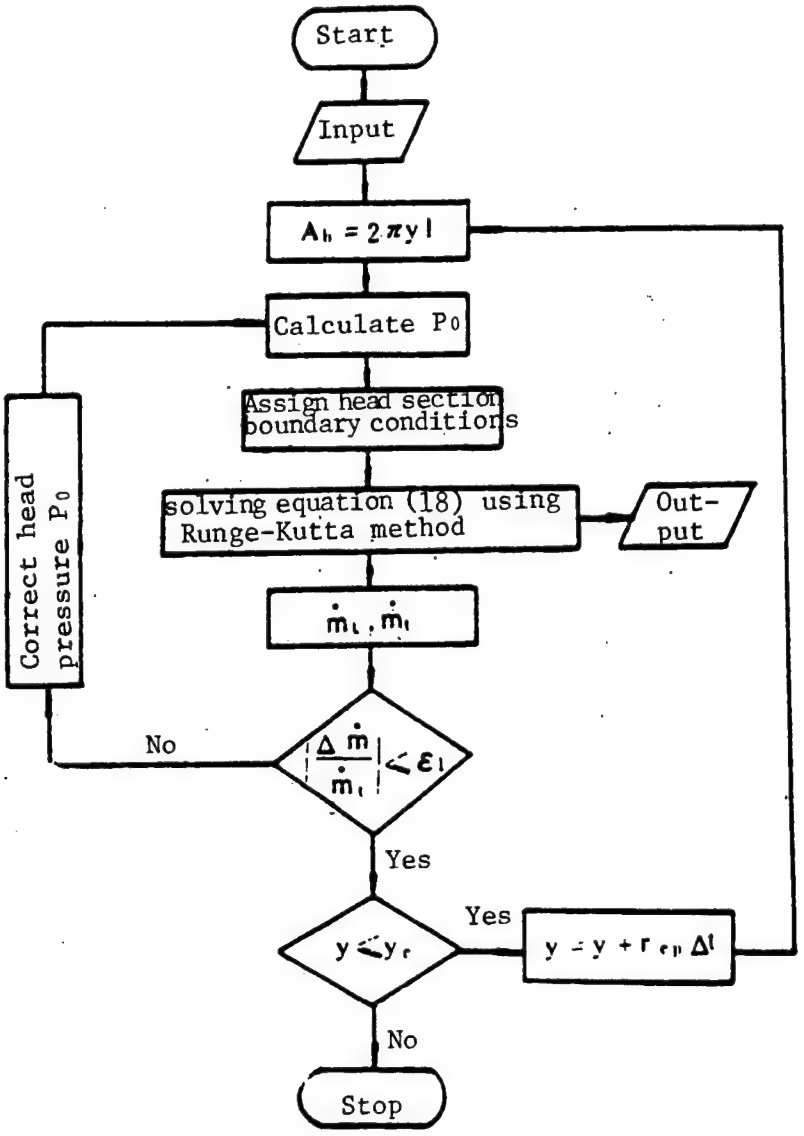

Figure 2. Flow Diagram of Numerical Procedure

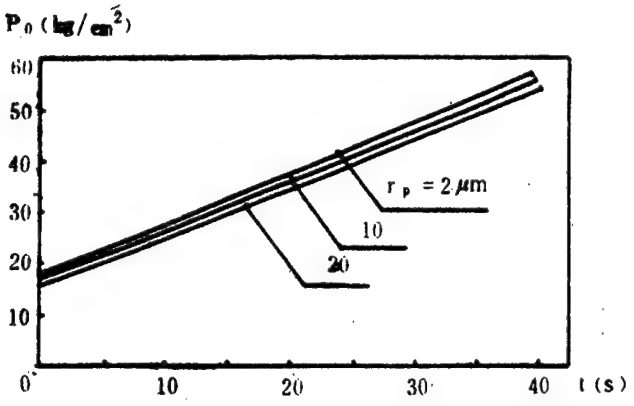

Figure 3. Pressure-Time Curve

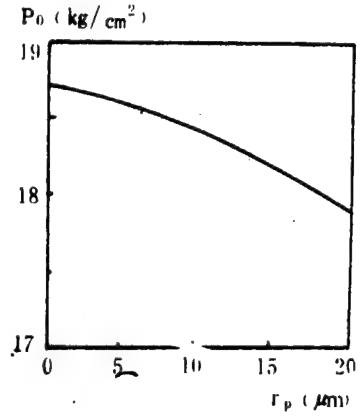

Figure 4. Effect of Particle Size on P_0

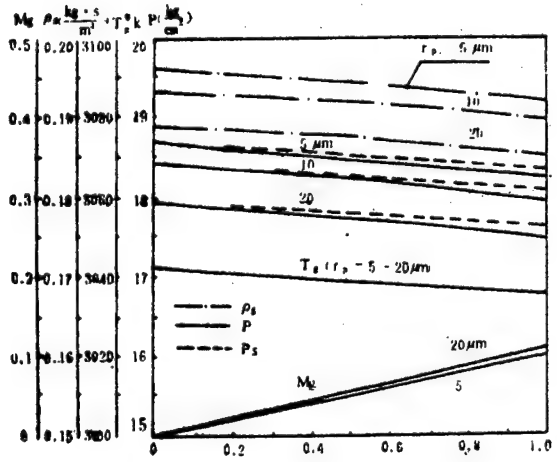

Figure 5. Distribution of Gas Phase Parameters in Two-Phase Flow

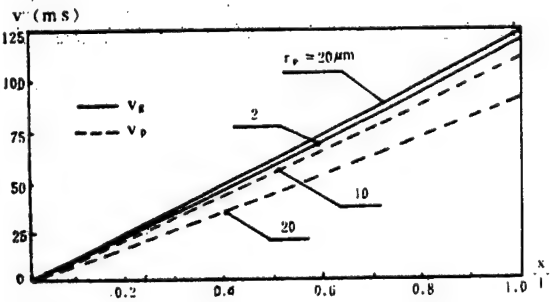

Figure 6. Distribution of Particle and Gas Phase Velocities in Two-Phase Flow

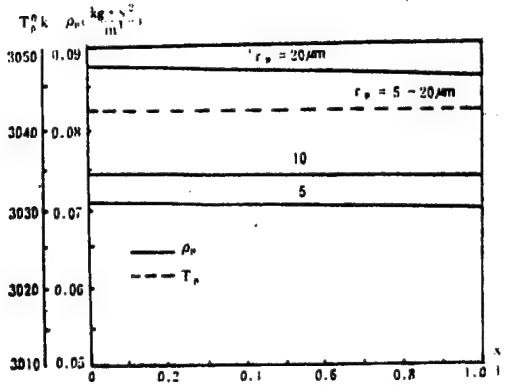

Figure 7. Distribution of Particle Parameters in Two-Phase Flow

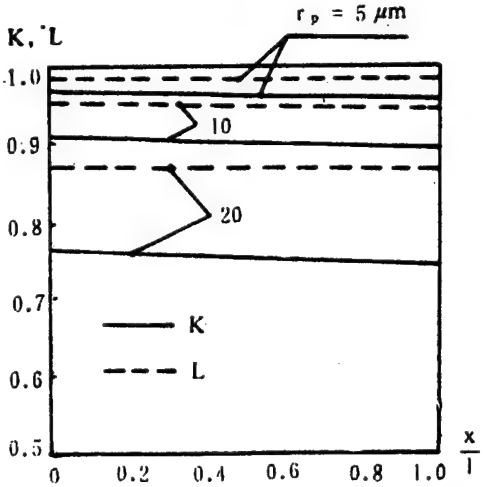

Figure 8. Distribution of Particle Velocity and Temperature Lag Numbers

Figure 7 shows the distribution of particle density and temperature along the channel. It can be seen that ρ_p drops slightly along the channel, and T_p remains essentially unchanged. The particle size has a significant effect on ρ_p, but little effect on T_p; specifically, ρ_p increases with increasing particle size.

Figure 8 shows the distribution of particle velocity lag number K and temperature lag number L along the channel at t=0 sec. One can see that K decreases slightly along the channel length and L remains essentially unchanged. This indicates that inside the combustion chamber the particle velocity lag (1-K) increases slightly along the channel and the temperature lag (1-L) remains unchanged. The smaller the particle, the less K varies along the channel (see Table 1); therefore, for small particle size, the two-phase flow in the combustion chamber can be treated as a constant lag flow.

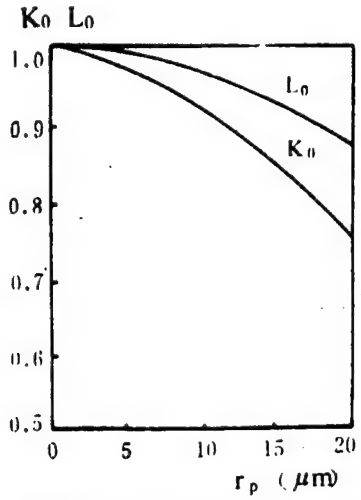

Figure 9. Effect of Particle Size on K_0, L_0

Table 1.

Particle radius r_p (microns)	K_0	Reduction in the value of K at propellant tail section (percent)
2	0.9958	0.020
5	0.9752	0.082
10	0.9123	0.263
20	0.7538	0.478

Table 2 presents a comparison of some of the key parameters of two-phase flow in the combustion chamber based on the numerical solution results and the constant lag flow calculations for different particle radius. It shows that the combustion chamber pressure P_0 and the total pressure at the tail section obtained from the constant lag flow calculations are somewhat lower than the results obtained from the numerical solution, whereas the other parameters are higher, but the relative error is less than 1 percent.

Table 2.

r_p	5	10	20
P_0 (kg/cm^2)			
Numerical solution	18.66	18.42	17.92
Constant lag flow	18.57	18.37	17.87
P_{SL} (kg/cm^2)			
Numerical solution	18.42	18.20	17.70
Constant lag flow	18.38	18.18	17.68
V_{GL} (m/sec)			
Numerical solution	119.64	120.90	123.62
Constant lag flow	120.46	121.50	124.26
V_{PL} (m/sec)			
Numerical solution	116.58	110.00	92.74
Constant lag flow	117.44	110.82	93.62

It is clear from equations (24), (25) that both K_0 and L_0 are functions of the particle radius r_p. As shown in Figure 9, both K_0 and L_0 decrease with increasing particle size, which implies that the particle velocity lag and temperature lag increase with particle size. Furthermore, $K_0 \leqslant L_0$; thus, for a two-phase nonequilibrium flow in the combustion chamber, the particle velocity lag is greater than the temperature lag.

IX. Conclusions

On the basis of the above discussion, one can draw the following conclusions:

1. The effect of two-phase flow causes a reduction in the combustion chamber pressure; the larger the particle size, the smaller the chamber pressure.

2. The two-phase flow has a significant impact on the flow field of the combustion chamber. As the particle size increases, the gas phase flow velocity increases, and the pressure, the total pressure, and the gas phase density all decrease. As the particle velocity decreases, the density increases. The particle size has very little effect on the gas phase or particle temperature.

3. In the combustion chamber, the particle velocity lag increases slightly along the channels; the temperature lag remains essentially unchanged. Furthermore, the particle velocity lag is greater than the temperature lag. For small particle size, the two-phase flow in the combustion chamber can be treated as a constant lag flow.

3012
CSO: 4008/342

LIFE SCIENCES

PATENT OFFICE PROCLAMATION ON STORING MICROORGANISMS

Beijing ZHONGGUO ZHUANLI [PATENT REVIEW OF CHINA] in Chinese No 5, 1985 pp 9-12

[Proclamation, issued 12 Mar 85: "Proclamation No 8 of the Patent Office of the People's Republic of China"]

[Text] The Patent Office of the PRC, pursuant to Article 25, Paragraph 1, Clause 1 of the Implementing Regulations of the Patent Law of the PRC, commissions the Common Microorganisms Center [2528 6639 1792 3932 3670 0022 1800] of the Chinese Microorganism Growth Medium Storage and Control Commission [0022 0948 1792 3932 3670 5497 4467 0202 5661 4619 3810 1201 0765 2585] and the Chinese Model Growth Culture Storage Center [0022 0948 0368 0992 1014 7402 3670 0202 5661 0022 1800] to take responsibility for the storage of microorganisms used in patented procedures.

Agreements between the parties concerned have been signed and are now in effect with regard to methods of storing microorganisms used in patented procedures. Storage methods are appended below.

The Common Microorganisms Center of the Chinese Microorganism Growth Medium Storage and Control Commission shall begin accepting applications on 28 February 1985.

Address: Common Microorganisms Center
Chinese Microorganism Growth Medium Storage and Control Commission
Zhongguancun, Beijing
Bank Account: People's Bank of China, Haidian, Beijing
Account Number: 8901-174. NOTE: The directions "for transfer to the account of the Common Microorganisms Center" should be clearly given at the Special Remittances Counter of the Bank.

The Chinese Model Growth Culture Storage Center shall begin accepting applications on 8 March 1985.

Address: Chinese Model Growth Culture Storage Center
Luojiashan Campus, Wuhan University, Wuchang
Bank Account: People's Bank of China
Luojiashan Office
Wuchang, Wuhan Municipality

Account Number: 89048. NOTE: The directions "for transfer to the account of the Chinese Model Growth Organisms Storage Center" should be clearly given at the Special Remittances Counter of the Bank.

So Ordered 12 March 1985

Methods for Storage of Microorganisms Used in Patented Processes of the Common Microorganisms Center of the Chinese Microorganism Growth Medium Storage and Control Commission

Article 1: The Patent Office of the People's Republic of China commissions the Common Microorganisms Center of the Chinese Microorganism Growth Medium Storage and Control Commission (hereinafter, the Storage Center) to assume responsibility for storage of microorganisms used in patented processes.

Article 2: The Storage Center shall assume responsibility for all bacteria, actinomyces, saccharomyces, filamentous fungi, plasmids existing in the above-mentioned host cells, and single-cell algal strains [5679 2701 zaozhu], except for animal pathogens.

Article 3: Persons requesting storage of a microorganism should submit two test-tube cultures of the said microorganism to the Storage Center, along with an application which clearly sets forth the following details:

1. That the microorganisms for which storage is requested is one used in a patented procedure;

2. Name and address of the person or unit making application;

3. Detailed description of conditions necessary for the growth, storage, and in vivo examination of the microorganism. When a complex growth medium is to be used to store several strains of microorganism, this description should include ingredients of the growth medium and at least one method for inspecting for the presence of each ingredient;

4. Names of species given to the stored microorganism by the applicant (with Linnaean nomenclature clearly indicated), or otherwise distinguishing markings;

5. A disclosure of any threat to health or to the environment posed by the microorganism or a disclosure that the applicant has no knowledge of such a threat.

Any foreign applicant with no permanent residence or business address in China must go through a Patent Agency recommended by the State Council in abiding by the above procedures.

Article 4: The Storage and Control Center shall commonly employ freeze-drying or liquid nitrogen as a storage method, and assumes no liability to check the biological features of microorganisms for which storage has been applied for. If an applicant desires that special storage methods be adopted or requests that checks be carried out with regard to the biological features of the

microorganism and its taxonomic nomenclature, said applicant should execute a separately signed agreement with the Storage Center at the time the growth medium for storing the microorganism is submitted.

Article 5: At such time as the Storage Center accepts a storage application and microorganism culture, it shall give the applicant written documentation, which shall include the following:

1. Storage unit's title and address;

2. Name and address of person or unit submitting application;

3. Date of acceptance of the microorganism culture;

4. Storage number given to the stored microorganism by the Storage Center;

5. Seal or authorized signature of the Storage Center.

Article 6: The Storage Center assumes full responsibility to maintain confidentiality during the storage period and shall not supply any information or samples of the said microorganism to any third party, other than to supply information about and samples of the stored microorganism as provided for elsewhere in these methods.

Article 7: The period of storage be the Storage Center shall be at least 30 years from the date of receipt of the microorganism, with a provision that storage be extended to at least 5 years from the time of any request for submission of a sample of the microorganism.

Article 8: Within one month of the date of receipt of a culture of an applied-for microorganism, the Storage Center shall carry out a test for its viability. Notice of the results of this test shall be given to the applicant and to the Patent Office in addition to being recorded by the storing unit.

Article 9: Storage shall be conducted by the Storage Center in strict accordance with storage methods in the applicant's disclosure. Within these conditions, the Storage Center assumes no liability for death, contamination, fire loss of, or change in any stored microorganism. Should one of the above-mentioned consequences be brought about by work error, the Storage Center shall compensate the applicant for damages.

Article 10: Should any condition mentioned in the previous article occur, the Storage Center shall notify the applicant to resubmit the microorganism culture, which it shall continue to store.

Article 11: Before a patent application is rejected, withdrawn, or withdrawal is pending, or before a patent is granted, the Storage Center shall provide samples of the stored microorganism only to units or individuals approved by the Chinese Patent Office. Once a patent application has been rejected, withdrawn, or withdrawal is pending, or once a patent has been granted, the Storage Center shall provide samples of the microorganism to units or individuals with the approval of and designation by the person originally applying for storage of the microorganism.

Article 12: The taking of samples from stored microorganisms by the Storage Center shall be entered into a registry to include the following information, which shall also be sent to the Patent Office:

1. Name and address of the individual or unit requesting that a sample of the microorganism be provided;

2. A statement by the applicant to whom a sample of a stored microorganism is to be supplied attesting that the microorganism shall not be transferred to any third party;

3. Storage number of the provided microorganism and a brief disclosure;

4. Date sample was supplied.

Article 13: Requests for storage of microorganisms or for supply of a microorganism sample shall be assessed in accordance with the following fee schedule:

1.	Storage fee (30 years)	1,500 Yuan
2.	Viability reports (each)	120 Yuan
3.	Supply of sample (each)	100 Yuan
4.	Other fees arranged by consultation among concerned individuals.	

Article 14: These methods shall take effect when signed by authorized representatives of the Patent Office and the Storage Center.

Article 15: Responsibility for interpretation of these methods shall reside with the Chinese Patent Office.

Methods for Storage of Microorganisms Used in Patented Processes of the Chinese Classic Growth Culture Storage Center

Article 1: The Patent Office of the People's Republic of China commissions the Chinese Model Growth Culture Storage Center (hereinafter, the Storage Center) to assume responsibility for storage of microorganisms used in patented processes.

Article 2: The Storage Center shall assume responsibility for all bacteria, actinomyces, saccharomyces, filamentous fungi, higher fungi, clones, viruses, plasmids existing in the above-mentioned host cells, and single-cell algal strains [5679 2701 zaozhu].

Article 3: Pathogenic microorganism growth cultures submitted for storage to the Storage Center from outside China must receive permission from the Chinese Ministry of Agriculture, Animal Husbandry, and Fishery, pursuant to regulations set forth in Article 15 of the "Rules on the Quarantine of Animals and Plants Imported To and Exported From the PRC."

Article 4: Persons requesting storage shall submit two test-tubes of growth culture for the said microorganism to be sent to the Storage Center, along with an application which clearly sets forth the following details:

1. That the microorganism for which storage is requested is one used in a patented procedure;

2. Name and address of the person or unit making application;

3. Detailed description of conditions necessary for the growth, storage, in vivo examination of the microorganism, and storage period. When a complex growth medium is to be used to store several strains of microorganism, this description should list constituents of the growth medium and at least one method for inspecting for the presence of each constituent;

4. Names of species given to the stored microorganism by the applicant (with Linnaean nomenclature clearly indicated), or else distinguishing markings;

5. A disclosure of any threat to health or to the environment posed by the microorganism or a disclosure that the applicant has no knowledge of such.

Any foreign applicant with no permanent residence or business address in China must go through a Patent Agency recommended by the State Council in complying with the procedures set forth in Articles 3 and 4 of these regulations.

Article 5: The Storage and Control Center shall commonly employ freeze-drying or liquid nitrogen as storage method, and assumes no liability for the biological features of microorganisms for which storage has been applied for. If an applicant desires that special storage methods be adopted or requests that checks be carried out with regard to the biological features of the microorganism and its taxonomic nomenclature, said applicant should execute a separately signed agreement with the Storage Center at the time the culture is submitted.

Article 6: Where application is made for storage of a cell matrix or virus requiring special growth conditions, the applicant shall supply such necessary growth medium and pharmaceutical materials as the Storage Center may require.

Article 7: At such time as the Storage Center accepts a storage application and microorganism culture, it shall give the applicant written documentation, which shall include the following:

1. Storing unit's title and address;

2. Name and address of person or unit submitting application;

3. Date of acceptance of microorganism culture;

4. Storage number given to the stored microorganism by the Storage Center;

5. Seal or authorized signature of the Storage Center.

Article 8: The Storage Center assumes full responsibility to maintain confidentiality during the storage period and shall not supply any information or samples of the said microorganism to any third party, other than to supply information about and samples of the stored microorganism as provided for elsewhere in these methods.

Article 9: The period of storage by the Storage Center shall be at least 30 years from the date of receipt of the microorganism, with a provision that storage be extended to at least 5 years from the time of any request for submission of a sample of the microorganism.

Article 10: Within one month of the date of receipt of a culture of an applied-for microorganism, the Storage Center shall carry out a test for its viability. Notice of the results of this test shall be given to the applicant and to the Patent Office in addition to being recorded by the storing unit.

Article 11: Storage shall be conducted by the Storage Center in strict accordance with storage methods in the applicant's disclosure. Within these conditions, the Storage Center assumes no liability for death, contamination, fire loss of, or change in any stored microorganism. Should one of the above-mentioned consequences be brought about by work error, the Storage Center shall compensate the applicant for damages.

Article 12: Should any condition mentioned in the previous article occur, the Storage Center shall notify the applicant to resubmit the microorganism culture, which it shall continue to store.

Article 13: Before a patent application is rejected, withdrawn, or withdrawal is pending, or before a patent is granted, the Storage Center shall provide samples of the stored microorganism only to units or individuals approved by the Chinese Patent Office. Once a patent application has been rejected, withdrawn, or withdrawal is pending, or once a patent has been granted, the Storage Center shall provide samples of the microorganism to units or individuals with the approval of and designation by the person originally applying for storage of the microorganism.

Article 14: Samples of stored microorganisms made by the Storage Center shall be entered into a registry to include the following information, which shall also be supplied to the Patent Office:

1. Name and address of the individual or unit requesting that a sample of the microorganism be provided;

2. A statement by the applicant to whom a microorganism sample is to be provided attesting that the microorganism shall not be transferred to any third party;

3. Storage number of the provided microorganism and a brief disclosure;

4. Date sample was supplied.

Article 15: The Storage Center may undertake and submit an appraisal of the biological features of a microorganism culture, where disputed, over procedures which are under investigation, objected to, or ineffective. Specific cases should be jointly worked out by the party requesting an appraisal and the Storage Center.

Article 16: Requests for storage of microorganisms or for supply of a microorganism sample should be assessed in accordance with the following fee schedule:

1.	Storage fee (30 years)	
	(1) Microorganisms (see note)	1,500 Yuan
	(2) Clones, animal or plant viruses	2,000 Yuan
2.	Viability reports (each)	
	(1) Microorganisms (see note)	120 Yuan
	(2) Clones, animal or plant viruses	200 Yuan
3.	Supply of sample (each)	
	(1) Microorganisms (see note)	100 Yuan
	(2) Clones, animal or plant viruses	200 Yuan

4. Other fees arranged by consultation among concerned individuals.

Article 17: These methods shall take effect when signed by authorized representatives of the Patent Office and the Storage Center.

Article 18: Responsibility for interpretation of these methods shall reside with the Chinese Patent Office.

Note: Bacteria, actinomyces, saccharomyces, filamentous fungi, higher fungi, bacteriophages, plasmids residing within host cells, and single-cell algal strains.

12303
CSO: 4008/366

LIFE SCIENCES

CHINA'S BIOENGINEERING PROSPECTS EXAMINED

Beijing GUANGMING RIBAO in Chinese 5 Oct 84 p 3

[Article by Chen Taosheng [7115 ? 5116]: "China's Bioengineering Prospects"]

[Text] Bioengineering is one of the three major core technologies (microelectronics, bioengineering and new materials) of the new technological revolution. It is closely linked to social production and to the people's well-being and health, and the role it plays in the national economy is as important as that of microelectronic technology. There is a worldwide effort to promote bioengineering research and development, and astonishing achievements are being made. China needs only to adopt the correct measures and strive to catch up, and it is estimated that the following advances can be made by the year 2000:

1. In the plant domain, the adoption of genetic engineering will select for new crop varieties that are high in protein and resistant to salinity, drought, disease, cold and pesticides.

2. In the animal domain, the adoption of cows bred through cytoengineering will increase birth rates by more than 10 times. The use of genetic engineering to produce bovine somatotropin may raise the quantity and quality of beef and milk.

3. The use of gene bacteria to produce large quantities of insulin, interferon, vaccines and so forth will allow us to arrive at treatments for some difficult and complicated diseases.

4. The use of unicellular proteins and amino acids (primarily lysine and methionine) and so forth to manufacture compound feeds may reduce the quantity of feed consumed to produce 1 jin of meat from the current 4 jin to 2 jin, thus saving 50 percent on grain for fodder.

5. The use of gene bacteria to produce various kinds of amino acids, raising the production rate by 2 or 3 times and lowering costs, will find many applications in medical, foodstuffs and feed industries.

6. The use of genetic engineering techniques to produce the sweet protein that is 3,000 times sweeter than sucrose (as compared with a 10 percent

solution of sucrose) and the mendong [7024 0392] sweetening agent that is 200 times as sweet as sucrose can satisfy the needs of diabetics and adiposis patients.

7. The use of bioengineering to produce nucleotide freshening agents to compound particularly fresh soy sauce and monosodium glutamate will increase receipts and create revenue.

8. The adoption of bioengineering to produce large quantities of high-fructose syrup to replace sucrose can satisfy the needs of soft drink production and canning.

9. We will use enzyme engineering to increase production of a kind of semi-synthetic penicillin antibiotic and we will reduce the output of tetracycline and other antibiotics with relatively serious side effects. This will reduce the occurrence of hearing loss and other side effects in patients taking antibiotics.

10. We will use new techniques of alcohol fermentation to produce alcohol directly from cellulose and hemicellulose, thus opening up a new nondepletable energy source.

11. Using the perfected fixed enzyme reactor and conducting glutamic-acid, citric-acid and other aerophilic fermentation will achieve the goals of reduced plant area, shortened fermentation time and improved fermentation efficiency.

12. The use of enzyme electrodes or sensors manufactured with fixed ensymes can accomplish clinical testing of glucose, cholesterol and so forth and make disease diagnosis easier.

13. The adoption of genetic engineering to improve the nitrogen-fixing activity of azotobacteria in the soil will reduce the use of nitrogen fertilizers.

14. The use of oxyethylene and propylene oxide produced by enzymatic menas as raw materials for the production of polyvinyl and polyacrylic plastics will enable us to switch gradually from a high-pressure, high-temperature petroleum processing technology to a production technology employing ordinary pressures and temperatures. This will save energy and alleviate pollution.

15. The use of "superbacteria" and specific bacteria types that can catabolize all sorts of hydrocarbons to purify the waste water from petroleum processing will make a contribution to environmental protection.

The points raised above are only the most apparent ones. If we can achieve them one after another it will unquestionably make an enormous contribution to the growth of China's national economy.

What must we do if we are to realize the above goals?

In zoological and botanical domains the applications of bioengineering present a rather high degree of difficulty. We should actively engage in basic research in these areas and strive for some sort of breakthrough.

With respect to microbiological fermentation, we should let gene engineering play the guiding role and base it upon strong, solid fermentation engineering. We should strive to develop new products and improve old ones in order to lower costs and improve results.

Some people say that the difficulties involved in genetic engineering work are many and that it is hard to achieve the desired results in a short period of time. This is correct. However, a thousand-li journey must be started by taking the first step. If we do not act now, when will we? In any case, China already has a certain foundation in genetic engineering and has achieved initial success with the use of genetic bacteria to produce insulin and hepatitis-B vaccine and so forth. If we continue our efforts and persevere for several years we will inevitably have new and even greater successes.

12510
CSO: 4008/35

SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

INSTITUTES OF AERONAUTICS, ASTRONAUTICS REVIEWED

Beijing HANGKONG ZHISHI [AEROSPACE KNOWLEDGE MAGAZINE] in Chinese No 5, May 85 pp 6-7

[Text] Beijing Aeronautical Institute

The Beijing Aeronautical Institute was established in 1952 as one of the 16 original key universities in the country. It was among the first State approved institutions to offer doctors and masters degrees. It is also one of the higher institutions designated for major expansion during the Seventh Five-Year Plan.

During the more than three decades since its establishment, the Beijing Aeronautical Institute has cultivated more than 20,000 graduates and advanced students who are playing a key role in China's aerospace industry. The Institute has also expanded considerably in size; it occupies over 1,300 mu of land, has more than 320,000 square meters of building space, and a 17,000-square meter modern library is currently under construction. The school has a graduate college and 12 departments which include material science and engineering, electronic engineering, automatic control, engine design, aircraft design and applied mechanics, computer science and engineering, manufacturing engineering, aeronautical system engineering, applied mathematics and applied physics, electro-mechanical engineering, foreign languages and social science. There are 33 different fields of specialization, 5 research buildings, 17 research offices, and 113 class rooms and laboratories which can be used for lectures and research. It has a total staff of over 4000, which include approximately 400 professors and associate professors,more than 1000 instructors, and over 600 research personnel. The school offers nearly 1000 courses, awards master's degree in 29 fields of specialization, and doctor's degree in 11 fields of specialization; graduate students are accepted in 42 different disciplines to work on more than 140 research projects. After this summer, the number of graduate students will exceed 1000. Each year, the Institute selects a group of students to be sent abroad for advanced study. The school has a regular four year curriculum and promotes a credit and scholarship system. Students with good moral characteristics and good academic records are eligible to receive scholarships; qualified graduating students are permitted to continue graduate studies toward a master's degree without an examination. Also, students who have accumulated the required number of credits

are allowed to graduate ahead of schedule or to receive a double bachelor's degree. In 1985, the Institute will recruit 1,500 new students from 26 provinces and cities across the country.

The Institute maintains an active academic atmosphere, and encourages student participation in scientific research; each year, it undertakes more than 400 research projects. Since the establishment of the Institute, more than 10 different types of flying vehicles have been developed and flight-tested by faculty members and students. In recent years, 9 research items received national innovation awards ranging from first to fourth place, nearly 30 items were on the list of international achievements in advanced technologies, and over 100 received the significant achievement award. More than 4000 academically significant papers were produced, over 100 of these have been published in foreign journals. In order to meet the needs of the open-door policy and the domestic free economy policy, the Institute has established more than 20 new technology development companies in Hong Kong, Shenzhen, Guangzhou, and Qingdao. The school has complete facilities for teaching, research and extracurricular needs; they include a computing center, an electronic center for education, a hospital, a factory, a gymnasium, two swimming pools, and two large sport fields equipped with 400-m tracks.

The Beijing Aeronautical Institute is highly interested in international academic exchange. In recent years, it has established inter-collegiate relations with many schools abroad; almost 1000 experts and scholars from over 20 countries and regions have visited, lectured, and participated in academic activities at the Institute, 16 of them were invited as honorary professors, consulting professors, and technical consultants. The Institute has sent more than 200 scholars to over 10 different developed countries to lecture, to visit, to study, and to participate in technical conferences. Currently, the Beijing Aeronautical Institute's goal is to develop the school into a center for both education and research.

Northwest Industrial College

The Northwest Industrial College is located in the ancient city of Xian. It is a polytechnical university with special strength in aeronautics; it is one of China's key institutions, and also one of the higher institutions designated for major expansion during the Seventh Five-Year Plan.

The Northwest Industrial College has the following 10 departments: airplane, aircraft engine, electronic engineering, computer science and engineering, aircraft manufacturing, automatic control, material science and engineering, space engineering, navigation engineering, and mathematical mechanics; it also has three sections: the fundamentals section, the graduate section, and the social science section. It has 4 research buildings and 10 research offices, and offers 39 different fields of specialization.

The college occupies approximately 100 mu of land and has 350,000 square meters of building space. It has a total staff of 3,900, which include 439 professors and associate professors, and 640 instructors and engineers. A bachelor's degree is offered in 30 fields of specialization, and a doctor's degree is offered in 11; there are 16 professors qualified to direct graduate

students working toward a doctor's degree. The school has more than 60 fully equipped laboratories. In recent years, it has completed construction on a computing center, a metrology center, a data processing center, a microscopic test center, and an electronic education center. The school also has an electrical/mechanical factory and an electronic factory to be used for teaching, testing research products, and for intermediate production. The 1 million-plus volume library, the large sports field, gymnasium, and swimming pools provide an excellent environment for the students.

The Northwest Industrial College is on a regular 4-year system. It has a curriculum based on a credit system which allows qualified students to skip certain courses by taking proficiency examinations; it also allows students to take courses in other departments or other specializations. Students who have fulfilled the credit requirements are allowed to skip certain courses by taking proficiency examinations; it also allows students to take courses in other departments or other specializations. Students who have fulfilled their credit requirements are allowed to apply for graduate school or to graduate ahead of schedule. At present, the school offers more than 200 elective courses; its total enrollment is about 6,400. In 1985, it will recruit 2000 new students from 25 provinces and cities; they include 230 students who will enroll in a 3-year program and 350 graduate students.

With education and research as its major goals, the College is highly interested in scientific research. In recent years, it has completed more than 300 significant research projects and has published over 2000 research papers; 100 of them have been published in foreign journals.

To emphasize technical exchange with other countries, the school has signed cooperative agreements with higher institutions and research organizations in the United States, West Germany, and Sweden. Since 1979, the College has invited 57 foreign scholars and professors to visit and to give lectures. Sixteen foreign scholars, experts and professors were invited as honorary professors or consulting professors of the schools. Each year, the college sends a group of teachers abroad to visit, to work and to participate in academic activities; it also sends a number of visiting scholars and students abroad for advanced study, thereby raising the academic standards of the College.

Since its establishment 28 years ago, the Northwest Industrial College has cultivated more than 20,000 engineers and scientists for the State. Today, it is marching toward the goal of developing the school into a center for education and research, and into a new socialistic university with Chinese tradition.

Nanjing Aeronautical Institute

The Nanjing Aeronautical Institute was established in 1952; it is a technical university whose major strength is in aeronautical engineering, but it also offers curriculum in physical sciences, management science, social science and human science. It was one of the key institutions first approved by the State Council to offer doctor's, master's and bachelor's degrees.

After more than three decades, the Institute has undergone considerable expansion; currently it has 10 departments, a graduate school section, two teaching sections, and it offers a total of 18 different fields of specialization.

The Airplane Department has three specializations: airplane design, helicopter design, aircraft environmental control, and life preservation;

The Engine Department has two specializations: aircraft engine and power plant control engineering;

The Automatic Control Department has four specializations: aircraft automatic control, instrument and measurement systems, electrical technology, and inertial navigation and instruments;

The Electronic Engineering Department has two specializations: electronic engineering and radio communications;

The Mechanical Engineering Department has three specializations: manufacturing technology and equipment, aircraft manufacturing engineering, and manufacturing engineering for precision machines and instruments;

The Aerodynamics Department has a specialization in aerodynamics;

The Engineering Management Department has a specialization in industrial management;

The Computer Science and Engineering Department has two specializations: computer software and computer applications;

The Material Science and Engineering Department offers courses in metallic materials and heat treatment, corrosion prevention, etc;

The Mathmatical Mechanics Department currently accepts graduate students only;

The Social Science Department offers courses in ideological politics;

In addition, there is a foreign language mathematics department.

The Institute has more than 20 special research organizations including the remote-pilot airplane research office and the aerodynamics research office; it has 38 laboratories which can be used for teaching and research; it has a large computing center, a test and measurement center, an electronic education center, and a computer-aided design center; it also has a library hall with over 10,000 square meters of building space and more than 700,000 books, and a new athletic hall is under construction. These facilities provide a good environment for the faculty and students to work, to learn, and to live.

The Institute is on a 4-year system. After graduating with a bachelor's degree, the student can directly apply for graduate school; a student with good moral characteristics and good academic records may be recommended as candidate for the master's degree without an examination. A superior graduate student may be recommended as candidate for the doctor's degree. Also, a certain proportion of the student population will study abroad for their

master's or doctor's degrees. In order to provide additional incentives for the students, graduating seniors who are morally, academically and athletically superior will be given preferential treatment in job assignment. The Institute offers scholarships for in-school students; entering new students with superior test scores may also receive scholarships the first year. This year the Institute will recruit 955 new students from 25 provinces and cities.

Currently there are 1,100 teachers at the Institute; they include many highly knowledgeable and respected experts, professors, and associate professors. Over the years, the Institute has more than 150 important scientific achievements, 11 of them received the national scientific conference awards and 4 received the national innovation awards. In addition, it has cultivated a large number of highly trained aeronautical engineers and scientists for the State, thus making a significant contribution to the four modernizations program.

3012
CSO: 4008/352

SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

BRIEFS

OPTICAL INSTRUMENTS STANDARDIZATION--The national conference on optical instruments evaluation, sponsored by the Bureau of Instrument and Meter Industry of the Ministry of Machine-building Industry, was held recently at Jiaji, Qionghai County. The conference was attended by 45 people from 42 scientific research organizations nationwide. During the conference, the standardizations--"the requirements and testing methods for anti-mildew, anti-fogging and rustproofing technologies of optical instruments" drafted by the Xintian Precision Optical Instruments Co. and "metric grating terminology" drafted by the Xintian Research Institute of Optical Instruments--were evaluated and accepted. The passage of these two standardizations has positive significance with regard to improving the quality of our optical instruments and closing the gap with the advanced nations. Also, technical evaluations on prototype instruments designed for use in a subtropical climate were carried out, employing the standard just passed. [Text] [Haikou HAINAN RIBAO in Chinese 10 Jan 84 p 1] 12922

NEW INSTITUTE ESTABLISHED--A research institute on chemical energy sources under the Ministry of Light Industry has been approved by the National Economic Council to be established in Suzhou. The construction of a research building, pilot plant and metal-processing shop of the institute began on New Year's Eve. The chemical energy sources are lightweight and portable. They are widely used in industry, agriculture, defense and science and technology. They are also indispensable in people's daily lives. The establishment of the institute will create a good environment for strengthening research on the basic theories of chemical energy sources and the development of new technologies and new series of products in order to put a gradual end to the backwardness of our chemical energy industry. [Text] [Nanjing XINHUA RIBAO in Chinese 28 Jan 84 p 2] 12922

FACULTY APPOINTMENTS MADE--At the Lunar New Year tea party sponsored by Shanghai University of Science and Technology yesterday, vice mayors Liu Zhenyuan [o491 2128 0337] and Li Zhaoji [2621 5128 1015] remarked: "The integration of colleges with the industrial and economic systems has to be strengthened in order to advance Shanghai's industries faster." It was a drizzly, cold day. But inside the assembly hall, it was all joy and cheer and spring was very much in the air. About 150 of those attending the party were either professors at the university or senior researchers from the 10 key research institutes who also teach at the university. They got together,

wished each other a happy New Year and offered advice for the revitalization of Shanghai's economy. The Shanghai University of Science and Technology maintains a good tradition of "integrating research institutes with academic departments." Since the founding of the university, renowned scientists such as Zhou Ren [0719 0088], Wang Yinglai [3769 2019 4202], Zou Yuanxi [6760 0337], Yan Dongsheng [0917 2639 3932], Wang You]3076 3731], Huang Yaozeng [7806 5069 2582], Gao Yisheng [7559 1837 3932] and Lu Hefu [4151 7729 4811] have all taken leadership roles in the university and departments. In recent years, 8 senior researchers from Shanghai-area institutes have been invited to take up additional leadership positions at the university and 38 famous scientists have been invited to join the faculty. In conjunction with related research institutes, the university has also been training graduate students. In order to strengthen further the connection between institutions of higher learning, research institutes and industrial and economic systems, the university has recently carried out scientific and technical cooperation with the Metallurgy Institute, Chinese Academy of Sciences, Shanghai Semiconductor Institute and East China Computer Institute on the subjects of large-scale integrated circuits, computer, etc. Agreements on long-term scientific and technical cooperation and technical training have been signed with the municipal instrument and meter bureau and the metallurgy bureau for the research and development of new-generation products. At the party, Vice Mayor Liu Zhenyuan fully approved these undertakings. He said: "These are good attempts on the part of institutions of higher learning to gear toward the needs of society and production." Yang Shifa [2799 1102 3127], president of the university; Jin Zhuqing [6855 2691 7230], chairman of the science and technology commission; and Shu Wen [5289 2429], advisor to the education and health office, also addressed the assembly. [Text] [Shanghai JIEFANG RIBAO in Chinese 5 Feb 84 p 1] 12922

TWO TECHNICAL ACHIEVEMENTS--While popularizing the new hydraulic technology of the 1980's, Lu Yongxiang [6424 3941 4382], associate professor at Zhejiang University, together with his coworkers, has obtained two major achievements last year, indicating that the developmental research of new fluid proportion control technology, which is distinctly Chinese, remains among the advanced of the world. The new fluid-proportion control technology that Lu Yongxiang invented in West Germany serves as a bridge that links computer and electronic technology with high-power hydraulic-control engineering. It is one of the major basic technologies in the renewal of the national economy and technology. Two years ago, he and coworkers from his Fluid-drive and Control Technology Laboratory obtained four significant results. Last year, they successfully developed the prototypes of "fluid-proportioning overflow valve" and "fluid-proportioning directional valve," whose technical features, in the opinion of experts, are considered advanced by international standards. Lu Yongxiang and his coworkers have also been actively helping related enterprises apply new technologies and carry out product renewal. In the past year, they have arranged technical transfers and scientific and technical cooperation with over 10 organizations from related state departmental committees and provincial and municipal enterprises. Moreover, five items of technology have already been transferred for production to Shanghai and Tianjin with marked economical benefits. [Text] [Shanghai WEN HUI BAO in Chinese 7 Jan 84 p 1] 12922

PROMOTION OF RESEARCHER ANNOUNCED--The Chinese Academy of Sciences has recently approved the direct promotion from assistant research fellow to research fellow of Hong Guofan [3163 0948 5672] of the Shanghai Biochemistry Institute for the breakthrough he made in nucleic acid studies. Hong Guofan, 43, graduated from the biology department of Fudan University and has worked on nucleic acid research at the Shangahi Biochemistry Institute, Chinese Academy of Sciences, for the past 20 years. On the recommendation of renowned biochemist Wang Yinglai [3769 2019 4202], he went to Cambridge, England, in 1979 to work at the Molecular Biology Laboratory of the Medical Research Council as a visiting scholar. Under the guidance of Professor Sanger, the renowned British biochemist and two-time Nobel laureate, he invented the non-random nucleic acid structure determination method. This important research paper was published in the journal BRITISH MOLECULAR BIOLOGY and received wide attention in biochemistry circles. He has received over 1,000 letters from scientists all over the world. This work has received high marks and is regarded as "a significant step in genetic research." Offers of permanent positions with high pay to do research have come from countries such as the U.S., Switzerland and Sweden. But he kindly declined and returned home last year. During his stay in England, he was also involved in the study of the nucleic acid structure of the lambda virus in collaboration with Professor Sanger. Together with 3 other foreign chemists, he determined the DNA sequence of the lambda virus, which is 48,500 base pairs long. This is by far the largest gene cluster, whose primary structure has been determined. These research works of Hong Guofan are highly admired in our biochemistry circles and by old-generation biochemists. They are regarded as original in nucleic acid studies and will have a profound impact in this area. After peer review by other biochemists and the Academic Affairs Committee of the Shanghai Biochemistry Institute, the Chinese Academy of Sciences has formally approved the direct promotion of Hong Guofan from assistant research fellow to research fellow. [Text] [Shanghai JIEFANG RIBAO in Chinese 24 Feb 84 p 1] 12922

CSO: 4008/1023

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25 July 1985

AUTHOR: QIU Xinfang [5941 6580 2455]
JIANG Jiliang [5592 3444 5328]
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ORG: Institute of Acoustics, Chinese Academy of Sciences

TITLE: "Investigation of the Mechanism of Sound Absorption by Boric Acid Relaxation in Sea Water"

SOURCE: Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Vol 10 No 3, May 85 pp 137-148

TEXT OF ENGLISH ABSTRACT: The dependence of the relaxation frequency and maximum absorption per wavelength of boric acid relaxation on $B(OH)_3$ and $NaHCO_3$ concentrations is obtained by the cylindrical resonator method. The experimental results may be explained by an apparent single-step process: $B(OH)_3 + CO_3^{2-}$ (total) + $H_2O \rightleftarrows B(OH)_4^-$ (total) + HCO_3^{2-} (total). Theory and experimental results show that the effects of calcium on the relaxation parameters of the boric acid relaxation can be interpreted by a coupled reaction system, which is equivalent to that of the apparent single-step process, including all ion association reactions.

AUTHOR: ZHENG Minhua [6774 2404 5478]
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TITLE: "A Study of Sound Reflection from Porous Material by Impulse Method"

SOURCE: Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Vol 10 No 3, May 85 pp 173-179

TEXT OF ENGLISH ABSTRACT: This paper presents a study of the reflection of sound pulses from porous material when the impulse sound source and receiver are located in a line perpendicular to the surface of the material. The transfer functions of the reflected sound wave were calculated from the experimental incident and the reflected sound pulses were calculated by use of the discrete Fourier transform. The impulse response of the reflected sound wave can be calculated theoretically under the assumption of idealized porous material. Both the local and extended reactions of the material were taken in the calculations. A comparison of the calculations for spherical and plane waves provides a measure of the effect of the spherical wave on the transfer function of the reflected sound wave. The reflections in the material are studied for a layer of porous material.

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TITLE: "Electromechanical Coupling Coefficients for Some Modes of Vibration of Lithium Niobate Single Crystal"

SOURCE: Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Vol 10 No 3, May 85 pp 180-189

TEXT OF ENGLISH ABSTRACT: In this paper formulas of coupling coefficients for thickness extensional and thickness shearing vibration modes along a rotated axis for lithium niobate are obtained by matrix calculating and tensor calculating methods. Electromechanical coupling coefficients of three modes of vibration along a rotated axis are calculated. The curves obtained possess some advantages for crystal use.

AUTHOR: ZHANG Junjie [1728 0193 2638]

ORG: China University of Science and Technology

TITLE: "Theoretical Calculation of Sound Velocities in Binary Liquid Mixtures of Weak Interaction"

SOURCE: Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Vol 10 No 3, May 85 pp 190-197

TEXT OF ENGLISH ABSTRACT: In this paper the expression for excess molar isentropic compressibility of liquid mixture is given as follows:

$$(\partial V^E/\partial p)_s = \sum_{i=1}^{m} M_i X_i/\rho_i^2 U_i^2 - \sum_{i=1}^{m} M_i X_i/\rho^2 U^2$$

from which the sound velocity in a liquid mixture of weak interaction can be expressed as

$$C = \left(\sum_{i=1}^{m} M_i X_i/\rho_i\right) \Big/ \sqrt{\left(\sum_{i=1}^{m} M_i X_i\right)\left(\sum_{i=1}^{m} M_i X_i/\rho_i^2 U^2{}_i\right)}$$

where X_i is the mole fraction of the ith component with molecular weight M_i, density ρ_i and velocity U_i. ρ and U are the density and velocity of the mixture, and m is the number of components in the mixture.

The sound velocities computed using the above expression in 36 binary systems of weak interaction agree with the experimental data very well. An interesting phenomenon of minimum sound velocity in binary liquid mixtures is also explained in light of the above expression.

9717
CSO: 4009/261

AUTHOR: None

ORG: Ministry of Chemical Industry

TITLE: "Chemical Industry Making Progress"

SOURCE: Beijing XIANDAI HUAGONG [MODERN CHEMICAL INDUSTRY] in Chinese Vol 4, No 6, 20 Dec 84 pp 1-7

ABSTRACT: For 34 years following the liberation in 1949, China's chemical industry grew from 177 million yuan, 1.6 percent of the national industrial production, to 49,179 million yuan, at 8 percent of the industrial production in 1983. In that year, there were some 404 large and medium-sized chemical enterprises out of a total number of 5,400 enterprises of all sizes, annually producing some 8,700,000 tons of sulfuric acid, 1,793,000 tons of soda ash, 2,123,000 tons of caustic soda, 16,770,000 tons of synthetic ammonia, 13,789,000 tons of chemical fertilizer and 12,710,000 rubber tires. Investments for agriculture-use chemicals is 53 percent of all investment in the chemical industry; these chemicals include fertilizers, insecticides and farm supplies. As a result, the average fertilizer application in 1982 was 10.3 kg per mu; some 2 out of 2.4 billion mu of insect pest-infected land was prevented and treated with insecticides each year, thus saving some 15 million tons of cereal grain and 300,000 tons of cotton. Some 15 million mu of crops was covered in 1983 with domestically-made plastic thin film, thus increasing the output by some 30 to 50 percent. Chinese-made synthetic rubber accounts for 35 percent of total rubber consumed at present, thus saving foreign exchange in importing natural rubber. The chemical industry is capable of independently designing and manufacturing complete sets of large and medium sulfuric acid plants, soda ash plants, synthetic ammonia plants, and rubber tires and products plants.

This article is a reprint of "Guanghui Di Chengjiu--Zhonghua Renmin Gongheguo Chengli Sanshiwu Zhounian Jinian Wenji [Selected Articles in Memory of the 35th Anniversary of Founding of the Chinese People's Republic--Glorious Achievements]" by Renmin Chubanshe [People's Publishing House]. The article was received for publication in August 1984.

10424
CSO: 4009/1042

AUTHOR: FANG Sheng [2455 3932]

ORG: Science and Technology Information Institute, Petroleum General Corporation

TITLE: "Optimization of China's Petrochemical Production"

SOURCE: Beijing XIANDAI HUAGONG [MODERN CHEMICAL INDUSTRY] in Chinese Vol 4, No 6, 20 Dec 84 pp 7-10

ABSTRACT: Optimization of productivity growth is important in the socialism stage. There are five aspects of optimization: (1) resource distribution optimization to use resources in the high value sectors; (2) resource use optimization for full utilization and in-depth processing; (3) production scale optimization as to enterprise size, installation and serial equipment; (4) industrial siting optimization in industrial park layouts near raw materials and markets with convenient transportation and proximity to ports; and (5) investment effect optimization in raising the rates of profit of investment and costs. To achieve productivity growth in the socialism stage, the nonadaptable portions between production relationships and productivity should be realigned. In addition, optimizing productivity growth should be stressed. The petrochemical industry ranks prominently in the national economy since petrochemical production occupies 4.1 percent of total industrial output: the synthetic fiber production accounts for 10 percent of all fibers; synthetic rubber production represents 29 percent of rubber consumption; and synthetic resin production accounts for 36 percent of all ammonia production. This petrochemical industry is based on China's petroleum output, ranking seventh worldwide.

As for the first two optimizations, China lags far behind the developed countries from the following table citing an example of ethylene, one of the high-value-added petrochemicals:

Table: Ratios of Ethylene Production to Petroleum Consumption of Various Countries in 1980

Name of country	United States	Japan	West Germany	France	United Kingdom	China
Ratio of ethylene to petroleum production in percentage	1.7	2.2	2.3	1.8	1.4	0.56
Figure in multiples of China's figure	3	3.8	4	3.1	2.4	1

The industrial park concept is not well established in China because each province wants its independent industrial complex, thus straining the infrastructure investments with facilities either inadequate to cope with demand or low in investment effectiveness. Distorted figures may play a part in calculating rates of return in capital investments and cost as China's price structure is irrational with excessively low prices for raw materials while with high prices for finished products. Therefore, economic benefits should be evaluated in weighing the real investment effectiveness. The article was received for publication in August 1984.

10424
CSO: 4009/1042

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TITLE: "An Interface for a Microcomputer-Controlled Direct-Reading Spectrometer System"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 12, No 9, Sep 84 pp 864-867

ABSTRACT: For the first time in China, the authors succeeded in using a microcomputer for the control of a photoelectric direct-reading spectrometer on the basis of a minicomputer controlled photoelectric direct-reading spectrometer. According to the microcomputer configuration and operational approach and characteristics of the input/output trunk line, the authors designed and built an interface. The paper describes the logic and circuit design as well as the function of interface. The microcomputer is a Hong Kong-made (Xinya Company) Video Genie System EG3003 model, which consists of a Z80 CPU, 16 KB RAM, 12 KB ROM, 4 KB MONITE, address interpreter circuit and I/O interface circuit. The software system includes assembly language, Level-II BASIC and their interpreter and system service programs. Four figures show a flowchart of asynchronous transmission, system interface logic block diagram, register circuitry, and arrangement of separation circuit. Some of the investigation was done by the Jilin Provincial Institute of Electronics Technology. The paper was received for publication on 28 May 1983.

10424
CSO: 4009/1036

AUTHORS: XIONG Yungao [3574 7189 7559]
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TITLE: "Design of Microcomputer-Controlled Warehouse Management System With High Performance"

SOURCE: Shenyang XIAOXING WEIXING JISUANJI XITONG [MINI-MICRO COMPUTER SYSTEMS] in Chinese No 1, 8 Jan 85 pp 42-48, 2

ABSTRACT: For the promotion of microcomputer applications, two guidelines are followed in designing this management system: (1) it is expected that a microcomputer can take on heavy tasks in warehouse management, and (2) it is expected that the system will have good performance. Through careful design, the system has general applications to some extent, adapting to the daily ledger with a considerable number of items in circulation, conversion of item names, and data compression (among other features). The management system has been in operation in the Nanfang Motive Power Machinery Corporation. The microcomputer used is the PDP11/03 model with 64 KB RAM, two 8-inch floppy disks, and an RT11 operating system. The first part of the paper presents the system operating principle and configuration. The second part describes the principal functions and features of the system. The third part presents the problem of general applications. The fourth part introduces the B-tree document organization. The fifth and the final part introduces the technique of item-name conversion and data compression. Thirteen figures show a daily ledger document, format of fixed-length data, formats of general and daily ledgers, B-tree example, nodes of B-tree, nodes of insertion, split of B-tree nodes, B_+-tree example, B-tree nodes in the system, establishment of B-tree and split process of nodes, conversions of item name and KEY, and four keys. Three tables list keys in daily ledger, examples of item name, and values of S and W.

10424
CSO: 4009/1043

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ORG: Wuhan First Metallurgical-Electrical Installation Corporation

TITLE: "Automatic Feed of Board Band Saw Controlled by Microcomputer"

SOURCE: Beijing DIANZI JISHU YINGYONG [APPLICATION OF ELECTRONIC TECHNIQUE] in Chinese No 1, 25 Jan 85 pp 4-7

ABSTRACT: In the 1970's, applications of digital circuits were widespread in China for automatic feed control in numerical control machine tools. Most of these devices are now obsolete but generally the execution mechanism is still good. The use of microcomputers to replace the obsolete numerical control devices is simple and leads to rapid results. The author describes the use of a TP-001 single-board microcomputer for the control, monitoring and display in the automatic positioning of a board band saw with vector interrupt approach. Automatic control of saw-blade feed is executed by a numerical control stand composed of more than 10 plugboards. This innovation can enhance processing accuracy, labor productivity, as well as lightening the workload. Five figures show system hardware circuitry and the transmission motor control circuit, as well as flowchart of the main program, and the interrupt service program of A and B ports.

10424
CSO: 4009/1034

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ORG: Siping Municipal Second Electronic Instrument Plant, Jilin Province

TITLE: "Application of TP801 Single-Board Computer in Automatic Control System of High-temperature Tungsten Slat Clinkering Furnace"

SOURCE: Beijing DIANZI JISHU YINGYONG [APPLICATION OF ELECTRONIC TECHNIQUE] in Chinese No 1, 25 Jan 85 pp 8-11, 30

ABSTRACT: Tungsten slat is the semifinished product in filament drawing, and the key sector of tungsten-filament production is the high-temperature clinkering of tungsten slat. Manual control of the clinkering temperature leads to inferior tungsten slat quality because of low adjustment accuracy. The article presents a TP801 single-board computer controlled automation system on high-temperature tungsten slat clinkering furnace with high control accuracy, ensuring high quality in tungsten filament, and production automation. Software function and design method are presented. Z80 assembly language is used for routine compiling. The system has only been through the stage of experimentation and debugging; basically the design requirements are fulfilled in simulation experiments. On-site operation remains to be done. The optimal control plan can be selected and some application software can be made into solid-state EPROM memory units, thus enhancing system reliability and processing speed. Five figures show the technique curves (current versus time), computer control system configuration, hardware and interface circuit, as well as flowcharts of main program and the interrupt service program. Two tables list time constants of five segments of first clinkering and eight segments of second clinkering.

10424
CSO: 4009/1034

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ORG: Computer and Automation Department

TITLE: "A Microcomputer Control System for Well-type Vaccum Cementating Furnace"

SOURCE: Chongqing CHONGQING DAXUE XUEBAO [JOURNAL OF CHONGQING UNIVERSITY] in Chinese Vol, 8, No 1 Mar 85 pp 93-99

TEXT OF ENGLISH ABSTRACT: An effective system of microcomputer control according to the control requirement of the well-type vacuum cementating furnace is presented. An optimized program structure which can succintly and easily adjust and increase or decrease control functions for its applied program method is also given. In addition, a calculating method, "The Intellectual Faculties Adjuster" which gave good control results, was suggested.

12949
CSO: 4009/1038

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TITLE: "Digital Simulation of HVDC Systems Using Companion Models of Network"

SOURCE: Chongqing CHONGQING DAXUE XUEBAO [JOURNAL OF CHONGQING UNIVERSITY] in Chinese Vol 8, No 1 Mar 85 pp 1-8

TEXT OF ENGLISH ABSTRACT: The application of numerical solution of companion model network in HVDC systems simulation is presented. And the mathematical models of HVDC systems with time-varying network topology are completed by using the theory of indefinite admittance matrix. In the given example, a checking-calculation for Graetz-Bridge circuit has been finished with successful results.

This method is suitable to the digital simulation of steady-state, transient-state and practically complex connection of HVDC systems, and significant for the simulation of AC and DC systems.

12949
CSO: 4009/1038

AUTHOR: ZHOU Siling [0719 1835 3781]
CHEN Jin [7115 6651]

ORG: Computer and Automation Department

TITLE: "Application of Self-tuning Controller to the Controlled Temperature of Furnace"

SOURCE: Chongqing CHONGQING DAXUE XUEBAO [JOURNAL OF CHONGQING UNIVERSITY] in Chinese Vol 8, No 1 Mar 85 pp 157-166

TEXT OF ENGLISH ABSTRACT: Presented here is a modified self-tuning algorithm based on self-tuning controller by D.W. Clarke to overcome the change of d.c.-value Ur and a simple method to overcome the unstability of covariance matrix P (k). Using two different software formats, i.e., BASIC Language and Assembly Language to implement the algorithm, the temperature of the diffusion furnace can be well controlled and satistactory results will be achieved.

12949
CSO: 4009/1038

AUTHOR: QIN Kao [6009 5072]

ORG: Computer and Automation Department

TITLE: "Characteristics and Digital Simulation of Fuzzy Controllers"

SOURCE: Chongqing CHONGQING DAXUE XUEBAO [JOURNAL OF CHONGQING UNIVERSITY] in Chinese Vol 8, No 1 Mar 85 pp 146-156

TEXT OF ENGLISH ABSTRACT: This paper discusses the design and response characteristics of microcomputer fuzzy controllers. It has many advantages: the fact response velocity, the short transition times, the low parameter sensitivity and the practical values to us. The microcomputer fuzzy controllers is a type of artificial intelligence controller. Because it has a great prospect for the control system of the high requirements, we may use the self-organizing microcomputer fuzzy controllers.

This paper used simplified fast algorithms and discussed the parameter effects and their design and digital simulation of fuzzy controllers.

12949
CSO: 4009/1038

AUTHOR: TONG Zhuan'en [0157 0278 1869]

ORG: Computer Center of Chinese Academy of Sciences, and Science Research Institute of Zhengzhou Railroad Bureau

TITLE: "DJS Computer and X-Y Three-pen Plotter"

SOURCE: Beijing DIANZI JISHU YINGYONG [APPLICATION OF ELECTRONIC TECHNIQUE] in Chinese No 10, [Oct] 84 pp 20-25

ABSTRACT: In order to meet engineering requirements, the author applied the technique of appropriate interface, communication control and data transmission to install an X-Y plotter in a work site about 5 km from the computer room. The plotter connects to a DJS-130 computer through a ϕ0.5 private line of the municipal telephone system, thus becoming an on-line communication system. The data transmission speed is 9,600 bits per second. The two-line half-duplex operation is adopted and the transmission error rate is less than 10^{-6}. The paper mainly presents the physical configuration, logic design and operation procedure of the on-line system. Each of the three above-mentioned aspects of the system is shown in a figure as follows:

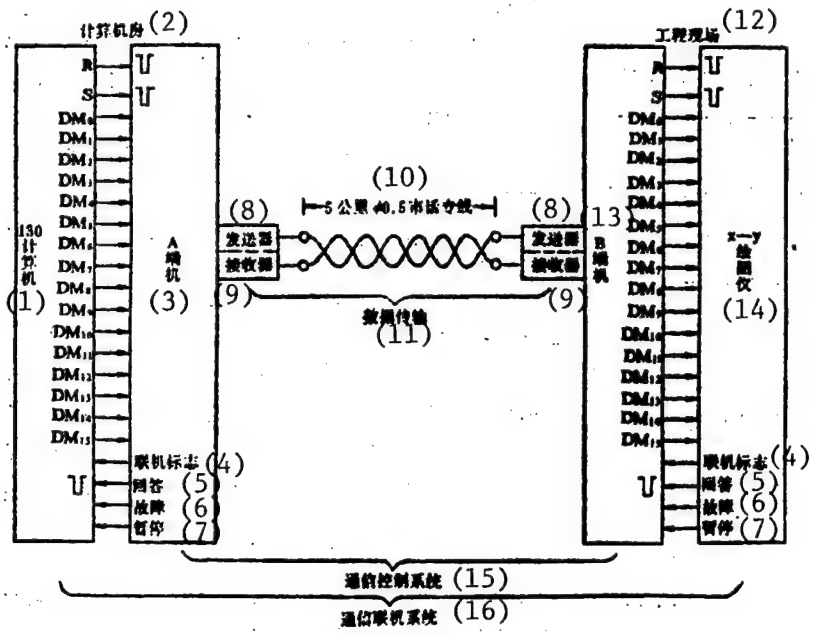


Figure 1. Physical Configuration of On-line Communication System

Key: 1. #130 computer; 2. Computer room; 3. Computer at terminal A; 4. On-line identification; 5. Response; 6. Malfunction; 7. Suspension; 8. Sender; 9. Receiver; 10. 5 km, ϕ0.5 private line of municipal telephone system; 11. Data transmission; 12. Work site; 13. Computer at terminal B; 14. X-Y plotter; 15. Communication control system; 16. On-line communication system.

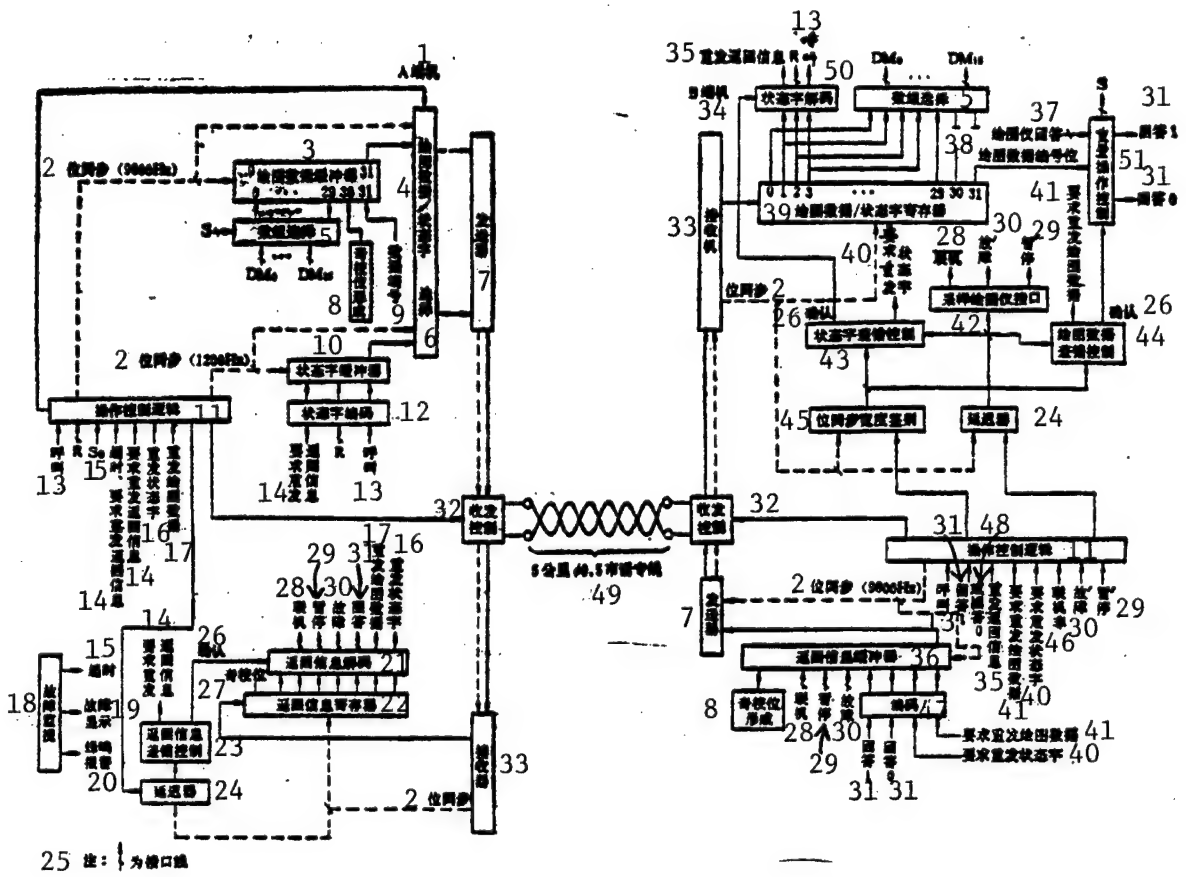


Figure 2. Logic Block Diagram of On-line System

Key: 1. Computer at terminal A; 2. Digit synchronization; 3. Buffer for plotting data; 4. Plotting data/status letters; 5. Selection of data block; 6. Selection; 7. Sender; 8. Formation of odd check digits; 9. Data number; 10. Buffer for status letters; 11. Operation control logic; 12. Coding of status letters; 13. Call; 14. Request of retransmission of return message; 15. Out of time; 16. Retransmission of status letters; 17. Retransmission of plotting data; 18. Malfunction monitoring; 19. Malfunction display; 20. Buzzer alarm; 21. Code interpretation of return message; 22. Storage of return message; 23. Error control of return message; 24. Device of delay transmission; 25. Note: ↑is the interface line; 26. Configuration; 27. Odd check digits; 28. On-line; 29. Suspension; 30. Malfunction; 31. Response; 32. Sending and receiving (transmission) control; 33. Receiver; 34. Computer at terminal B; 35. Retransmission of return message; 36. Buffer for plotting data/status letters; 41. Request to retransmission of status letters; 40. Request for retransmission of plotting data; 42. Interface of sampling plotter; 43. Error control of status letters; 44. Error control of plotting data; 45. Width discrimination of digit synchronization; 46. Not on-line; 47. Coding; 48. Operation control logic; 49. 5 km, Ø0.5 private line of municipal telephone system; 50. Decoding of status letters; 51. Control of repetition operation.

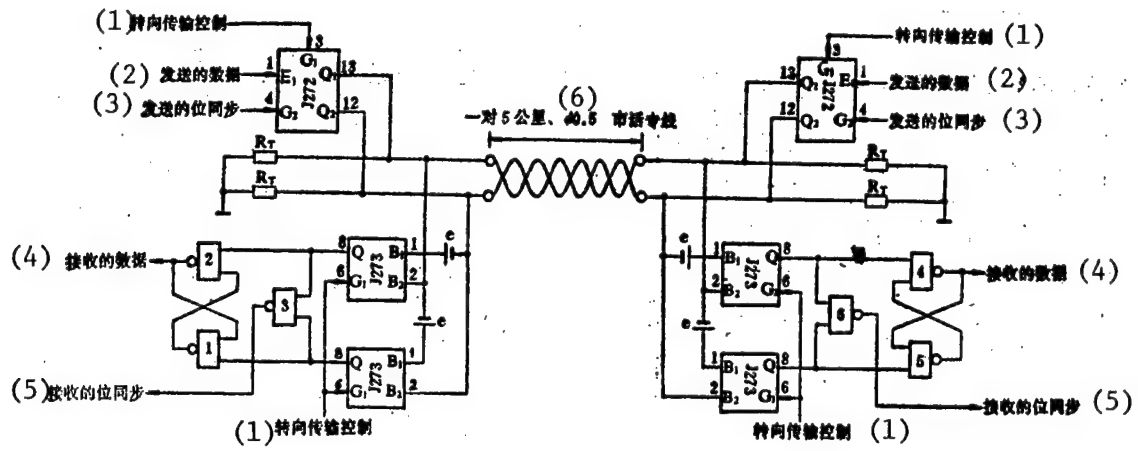


Figure 4. Data Transmission Mode

Key: 1. Control of change-direction transmission; 2. Sending data; 3. Sending digit synchronization; 4. Receiving data; 5. Receiving digit synchronization; 6. One pair of private lines (5 km, Φ0.5) of the municipal telephone system.

Five other figures show configuration of plotting data, time relationship of data and digit synchronization of sending and receiving terminals, time relationship of operating subsystem with and without repetition operation, and time distribution of the system. Three tables show definitions of return message and coding of status letters, as well as control characters of change-direction transmission.

10424
CSO: 4009/1023

JPRS-CST-85-024
25 July 1985

AUTHOR: TAN Weihan [6223 4850 5060]

ORG: Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

TITLE: "Research on Laser-Plasma Interaction in China in the Last 10 Years"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 11 No 11, 20 Nov 84 pp 641-647

TEXT OF ENGLISH ABSTRACT: Research on laser-plasma interaction in China was conducted in parallel with the high power laser technique. Since 1964 the high power Nd:glass laser system has been developed, and laser breakdown and laser-focusing in the plasma have been observed by focusing a 1.06 μm laser beam in the atmosphere. In 1973, frozen deuterium and LiK, CD_2 plate targets were irradiated with a 10^{10} W laser beam, and a neutron yield of 1×10^3/shot was obtained. In 1974, with a 10^{11} W laser beam shotting on CD_2 plate targets, the anomalous laser absorption and hard X-ray emission from plasma were observed, with neutron yield of more than 2×10^4/shot being obtained. From 1975-1980, the compression of glass microballoon targets was observed by using the six-beam laser facility. In addition, many laser-plasma interaction experiments, such as second harmonic emission, X-ray line spectrum diagnostics, K-edge absorption measurements for electron temperatures and Faraday cup charge collectors for particle measurements, have been carried out.

AUTHOR: ZHANG Meizhen [1728 2734 3791]
LI Chengfu [2621 2052 1381]
ZHOU Yongzong [0719 3057 1350]

ORG: Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

TITLE: "Lasing Characteristics of High Quality Nd:YAG Crystals Grown by Temperature Gradient Technique"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 11 No 11, 20 Nov 84 pp 665-666

TEXT OF ENGLISH ABSTRACT: A Nd:YAG crystal of ϕ5x50 mm in size was grown by the temperature gradient technique. It has good optical homogeneity (interference fringe number is zero) and an efficiency of 1 percent at 1 or 2 pps. It can easily be operated in the TEM_{00} mode.

9717
CSO: 4009/96

AUTHOR: DENG Ximing [6772 6932 6900]
LIANG Xiangchun [2733 0686 2504]
CHEN Zezun [7115 3419 1415]
et al.

ORG: Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

TITLE: "Uniform Illumination of Large Focal Targets Using a Lens Array"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 5, 20 May 85 pp 257-260

TEXT OF ENGLISH ABSTRACT: By inserting an array composed of nearly 100 similar lenses into a common focal system, the uniformity of the illumination of a target can be improved and not be affected by the near field distribution of laser beams.

Reported in this paper are the analyses of geometrical and physical optics of the lens array, which are then compared with the experimental results.

AUTHOR: ZHANG Dake [1728 1129 0668]
WANG Xiaoyi [3769 1420 8381]
et al.

ORG: Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

TITLE: "Effect of Amplified Spontaneous Emission on Space Coherence of the XeCl Laser"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 5, 20 May 85 pp 261-265

TEXT OF ENGLISH ABSTRACT: In this article, the space coherence of the XeCl laser is measured with varying cavity Q using Young's experiment. It is shown that the amplified spontaneous emission (ASE) is an important factor affecting the space coherence of XeCl lasers. This influence can be suppressed effectively by properly choosing the reflectivity R of the cavity output mirror.

AUTHOR: WANG Xiaojing [3769 2400 2417]

ORG: Department of Physics, Hangzhou University

TITLE: "Thermal Stability of Parallel-plane Resonator with an Internal Thermal Thick Lens"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 5, 20 May 85 pp 266-270

TEXT OF ENGLISH ABSTRACT: Optical pumping of solid-state lasers will induce axial thermal elongation and radial gradient of the refractive index in the laser rod, which may be summarized as an effect of the thermal thick lens. The insensitive condition of the parallel-plane resonator to the thermal thick lens is directly derived by taking the derivative of the beam spot size to the focal length of the thermal lens at the output mirror of the resonator. Application limitations are discussed.

AUTHOR: TANG Xingli [3282 2502 6849]
TAO Yongxiang [7118 3057 4382]
ZHANG Zhaoyang [1728 2600 7122]
et al.

ORG: Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences

TITLE: "Investigation of Characteristics of Flashlamp Pumped Planar Waveguide Dye Laser"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 5, 20 May 85 pp 271-274

TEXT OF ENGLISH ABSTRACT: The tuning characteristics of a planar waveguide dye laser driven by xenon flashlamps are described. With a planar structure, a narrow bandwidth of down to 8 GHz (FWHM), tuning range of 460 Å and tuning efficiency of 85 percent have been obtained using Rhodamine 6G. The beam divergence of this laser has been measured.

AUTHOR: LIU Dawei [0491 6671 0251]
SUN Shulan [1327 2885 5695]
JIANG Chongde [5591 1504 1795]
WANG Demin [3769 1795 3046]

ORG: LIU, SUN and JIANG all of the Institute of Mechanics, Chinese Academy of Sciences; WANG of Factory No 706, Fourth Ministry of Machine Building

TITLE: "High Power Pulsed Dye Laser Oscillator-Amplifiers"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 5, 20 May 85 pp 275-278

TEXT OF ENGLISH ABSTRACT: A dye laser with a double prism of a one-dimensional beam-expander, which is longitudinally pumped by a frequency doubled Nd:YAG laser, is reported. The total efficiency of the dye laser after two stages of amplification is 31 percent for Rh6G. The energy of the pumping beam is 40 mJ, with tunable dye laser output of 12.2 mJ (2MW). A line width of 0.12 A was obtained. The quality of the laser output beam is good. The repetition was 10 Hz when a circulating system was used.

AUTHOR: WANG Wenyun [3769 2429 7301]
MING Changjiang [2494 7022 3068]
et al.

ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "Pulsed Laser-induced Chemical Reaction of Porphyrins"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 5, 20 May 85 pp 279-282

TEXT OF ENGLISH ABSTRACT: The effect of pulsed nanosecond radiation from a frequency doubled Nd:YAG laser on several porphyrins in three solvents (chloroform, benzene, methanol) has been studied. For all three porphyrins (PPM, HPM, TPP), only irradiation in $CHCl_3$ solutions could bring about the appearance of new spectra and the disappearance of the original ones, with this phenomenon never occurring in benzene or methanol solutions. The resulting products have been identified as the corresponding protonated porphyrins. We assume that the dielectric breakdown of chloroform most probably accounts for the reaction pathway.

AUTHOR: HU Shuqin [5170 3219 3830]

ORG: Institute of Physics, Chinese Academy of Sciences

TITLE: "Analysis for Signals and Noises of 90° Thomson Scattering Experiment--Key Points in Optical Design of 90° Thomson Scattering Apparatus for CT-6B Tokamak"

SOURCE: Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 12 No 5, 20 May 85 pp 292-297

TEXT OF ENGLISH ABSTRACT: In this paper the signals and noises obtained in a 90° Thomson scattering experiment on Tokamak are analyzed. A ruby laser was used in the experiment as the light source, and a high scattering signal level and high signal-to-noise ratio were obtained with the apparatus. The key points in the optical design of the 90° Thomson scattering apparatus for the CT-6B Tokamak are explained.

9717
CSO: 4009/260

JPRS-CST-85-024
25 July 1985

AUTHOR: WU Guochuan [0702 0948 6861]
LAI Jie [6351 2638]

ORG: Nanjing Aeronautical Institute

TITLE: "Characteristics of an Axisymmetric Turbulent Boundary Layer Near Separation"

SOURCE: Beijing LIXUE XUEBAO [ACTA MECHANICA SINICA] in Chinese Vol 17 No 1, 1985 pp 41-49

TEXT OF ENGLISH ABSTRACT: In this paper criteria for the separation of the axisymmetric turbulent boundary layer as well as for the intermediate stages of the development toward zero stress are presented. The effect of lateral surface curvature on the flow is considered through the ratio of boundary layer thickness to the radius of the wall. The theoretical curves, including the skin-friction coefficients, calculated by the present method agree with experimental data quite well.

AUTHOR: TING Aili [0002 7224 7787]

ORG: Department of Mathematics, Beijing University

TITLE: "Three Distinct Stages of Unsteady Flow Behind the Shock Wave Formed by the Normal Reflection of a Planar Strong Point Blast Wave from a Wall"

SOURCE: Beijing LIXUE XUEBAO [ACTA MECHANICA SINICA] in Chinese Vol 17 No 1, 1985 pp 50-55

TEXT OF ENGLISH ABSTRACT: Shock fitting and a family of continuous C-characteristic lines were used for the normal reflection of a planar strong point blast wave from a wall. Several techniques have been devised in order to increase the accuracy of calculation of the problem having two complex singularities. New data for the flow field near the wall up to very late time are obtained. Descriptions are given for the three stages, each possessing distinct gas dynamic features, such as the orientation of characteristics, paths of fluid particles, distribution of entropy, etc.

AUTHOR: SONG Yuzhao [1345 5148 0340]
YANG Guitong [2799 2710 6639]
WANG Dujing [3769 4648 2417]

ORG: SONG and YANG of Taiyuan University of Science and Technology; WANG of Shanxi Agricultural University

TITLE: "Penetration Analysis of an Axisymmetric Projectile to a Semi-infinite Target"

SOURCE: Beijing LIXUE XUEBAO [ACTA MECHANICA SINICA] in Chinese Vol 17 No 1, 1985 pp 56-63

TEXT OF ENGLISH ABSTRACT: The process of semi-infinite target penetration is studied in this paper. Under certain assumptions the analysis of propagation of the plastic wave in the target and the traction on the surface of the projectile is given. The results calculated from the formula derived in this article agree well with experimental results.

9717
CSO: 4009/246

AUTHOR: ZHONG Bingwen [6988 3521 2429]

ORG: Beijing Aeronautical Materials Research Institute

TITLE: "The Influence of Tempering Temperature on Retained Austenite in 30CrMnSiNi2A Steel During Austempering"

SOURCE: Beijing JINSHU RECHULI [HEAT TREATMENT OF METALS] in Chinese No 4, Apr 85 pp 8-11

TEXT OF ENGLISH ABSTRACT: In order to determine the influence of metastable phase retained austenite and its structural features on the fatigue properties, etc., the distribution and transformation of retained austenite, specimens of 30CrMnSiNi2A steel austempered and tempered at different temperatures were examined with a transmission electron microscope. The orientation relationship among martensite, retained austenite and carbides is discussed.

AUTHOR: GU Fengying [0657 7685 5391]
WANG Zhenmin [3769 2182 3046]
et al.

ORG: Taiyuan University of Science and Technology

TITLE: "Study of Tungsten Ionic Surface Alloying by Double Layer Glow Discharge and Following Heat Treatment"

SOURCE: Beijing JINSHU RECHULI [HEAT TREATMENT OF METALS] in Chinese No 4, Apr 85 pp 39-44

TEXT OF ENGLISH ABSTRACT: This paper deals with a study of effects of tungsten and molybdenum ionic surface alloying and the three following heat treating processes on the surface microstructures and properties of four kinds of steel. The experimental results show that the surface hardness and corrosion resistance of the treated steels are increased remarkably.

9717
CSO: 4009/255

AUTHOR: CHEN Sixiong [7115 0843 3574]

ORG: Institute of Mechanics, Chinese Academy of Sciences

TITLE: "Incremental Mass Matrix and Radiation Attenuation Matrix of Partially Infiltrated Three-dimensional Oscillating Object"

SOURCE: Beijing KEXUE TONGBAO [SCIENCE BULLETIN] in Chinese No 2, 1985 pp 93-97

ABSTRACT: The paper derives mathematical formulas for incremental mass matrix and radiation attenuation matrix of a partially infiltrated three-dimensional oscillating object. It is assumed that the flow motion is caused by the periodic motion of small oscillating amplitude of the above-mentioned object; the fluid is incompressible, inviscid and irrotational. By referring to C. C. Mei: THE APPLIED DYNAMICS OF OCEAN SURFACE WAVES, Chapter 7, Wiley-Interscience, New York, 1982, elements of the incremental mass matrix and radiation attenuation matrix are obtained. At the conclusion of the paper, equation (42) is derived as the asymptotic value of the radiation attenuation matrix element.

The paper was received for publication on 7 February 1984.

10424
CSO: 4009/189

AUTHORS: ZHAO Delu [6392 1779 4389]
WU Dacheng [0702 1129 6134]

ORG: ZHAO of Institute of Chemistry, Chinese Academy of Sciences; WU of Chengdu University of Science and Technology

TITLE: "Monte Carlo Approach to Polymer Degradation"

SOURCE: Beijing SHUXUE DE SHIJIAN YU RENSHI [MATHEMATICS IN PRACTICE AND THEORY] in Chinese No 3, Jul 84 pp 18-21

ABSTRACT: Investigation of polymer (synthetic fiber, resin and rubber) is important and practical for polymer processing and aging. The simplest case of polymer degradation is that all crosslinking bonds can be randomly cut; this is called irregular degradation. The probability of bond scission is called the degree of degradation. Irregular degradation can be interpreted with mathematical analysis. The authors discovered that the Monte Carlo simulation calculation is a simple method of studying polymer degradation to be adaptable to various non-irregular degradation regimes. Using the Ovenall regime as an example, the authors present the steps of calculation process under the Monte Carlo approach. A Cromenco computer was used for calculations in the study; the random numbers were obtained from the computer's resident program. Three figures show a comparison between the Monte Carlo calculation results of the Ovenall regime, and a comparison between simulation calculation results and data from a paper by ZHU Shannong [2612 0810 6593] and QIAN Renyuan [6929 0086 0337] on HUAXUE XUEBAO [CHEMISTRY JOURNAL], 29:19 (1963).

10424
CSO: 4009/1040

AUTHOR: SONG Feijun [1345 5481 0689]

ORG: Beijing Institute of Photographic Equipment and Technology

TITLE: "Laser Speckle Effect"

SOURCE: Beijing WULI [PHYSICS] in Chinese Vol 14, No 3, Mar 85 pp 140-146, 156

ABSTRACT: When a laser is beamed onto an optically coarse surface (with an average up-and-down surface relief exceeding the wavelength magnitude), the interference and superposition of wavelets scattered by many randomly distributed plane elements form a reflected light field with random distribution of spatial light intensity with a granular structure. This is called the laser speckle effect. This phenomenon was observed not long after the laser made its advent. It was then considered as noise (disturbance in the physical sense). From further study, however, the speckle field was found to be capable of use as a message carrier for interference calculation, graphic processing and other applications, thus stirring broad interest among researchers. The paper presents the fundamental statistical characteristics of the speckle effect and the primary applications of speckle technology. Seven figures show speckles in free space, imaging speckles, Fourier transform of Rayleigh-Sommerfeld diffraction, double-exposure speckle diagram with vertical illumination of fine laser beam, smoothing of streaks, optical message processing system, and the 4f system. The author expresses his gratitude to Xu Daxiong [1776 1129 7160], Wang Ben [3769 2609] and Shen Shujun [3088 2885 6746] of the Beijing Postal and Telecommunications College, and Yu Guoming [0060 0948 2494], Yin Bianjie [7113 6708 2638], An Banglin [1344 6721 2651] and Wu Yan [0702 8746] of the Beijing Institute of Photographic Equipment and Technology for their manifold assistance.

10424
CSO: 4009/237

AUTHOR: WANG Zugeng [3769 4371 6342]

ORG: Department of Physics, Huadong Normal University

TITLE: "Optical Pumping and Generation of Stimulated Emission in Atomic and Molecular Vapor"

SOURCE: Beijing WULI [PHYSICS] in Chinese Vol 14, No 3, Mar 85 pp 147-150, 164

ABSTRACT: Optical pumping in atomic and molecular vapor is an important research direction in atomic-molecular physics and laser technology. For about a decade, much research was being conducted while new regimes and results appear as time passes. Recently, the author and his colleagues applied the molecule-atom dual photon mixed with resonance regime in producing infrared excitation radiation corresponding to 6s→5p, 5p→5s and 5p→3d of potassium atom. A table lists all regimes (described in the paper) of optical pumping and excited radiation. Five figures show the laser installation of a homonuclear diatomic molecule, its pumping and emission, production of an infrared laser, optical pumping and excited emission in cesium, energy level of lithium, as well as optical pumping excitation, ionization and spontaneous ionization of Tm atom.

10424
CSO: 4009/237

AUTHOR: ZHANG Jingye [1728 2417 2814]

ORG: Institute of Modern Physics, Chinese Academy of Sciences

TITLE: "High Nuclear Spin States"

SOURCE: Beijing WULI [PHYSICS] in Chinese Vol 14, No 3, Mar 85 pp 151-156

ABSTRACT: The field of high nuclear spin states was pioneered by the school of A. Bohr and B. Mottelson in the 1950s. With the great advances made in building accelerators and means of sounding in the early 1970s, many new experimental results further developed the theory of the 1950's. Currently, the high nuclear spin states have become a very active leading edge in nuclear physics, especially heavy ion physics, spurring prodigious efforts in theoretical and experimental work worldwide. The paper enumerates the advances of the subject field.

In China, many researchers in nuclear physics are actively investigating high nuclear spin states. Beginning from the mid-1970s, papers on this field were published in Chinese journals. Since the 1980s, Chinese researchers have presented papers at international symposiums and in journals. Six figures show the backbending phenomenon in the diagram of rotational momentum versus the square of the rotational frequency, nuclear spin momentum as the summation of angular momenta, two types of rotation, belt-crossing, energy spectrum of quasi-neutrons, relationship between neutron number and Fermi energy of Dy isotope, and the nuclear phase of Dy. The author thanks Jia Yujing [6328 6276 0079] for his drawings.

10424
CSO: 4009/237

AUTHORS: XING Lei [6717 4320]
YU Guiju [0060 2710 5468]

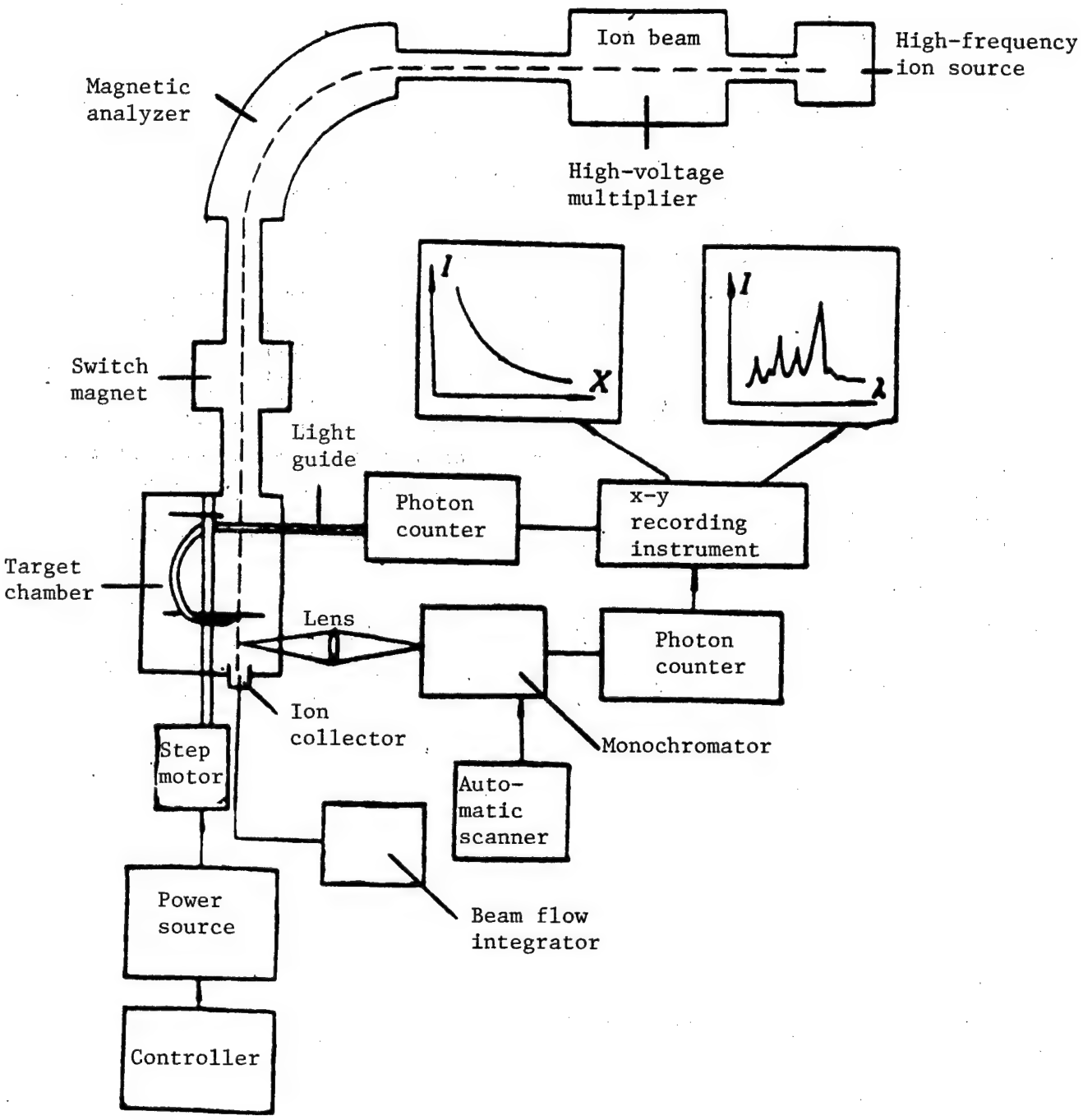
ORG: XING of Department of Physics, Beijing University; YU of Institute of Physics, Chinese Academy of Sciences

TITLE: "Beam Foil Spectroscopy and Its Present Status"

SOURCE: Beijing WULI [PHYSICS] in Chinese Vol 14, No 3, Mar 85 pp 129-134

ABSTRACT: Since its advent in the last century, spectrum analysis has rapidly developed. Laser and beam foil light have been two new light sources, since the 1960s. A series of new spectrum techniques was developed from the laser because of its good monochromaticity and orientation, as well as high brightness. Due to its many unique characteristics, the beam foil light source also rapidly developed into an independent discipline with multiple applications. The paper first presents the fundamental principle and characteristics found in experiments in beam foil spectroscopy. Its application and recent development are then described with some typical experimental results. A sketch diagram of the experimental layout of beam foil spectroscopy is shown in the attached sheet.

Six other figures show beam foil spectrum lines, skip of energy level, attenuation curve of skip, quantum beat, Fourier transform and displacement. The authors express their gratitude to teacher Wang Duanwei [3076 4551 0251] of Department of Physics, Beijing Normal University for his assistances.



10424
CSO: 4009/237

AUTHOR: ZHANG Yuheng [1728 5940 1854]
LIU Hongbao [0491 1347 1405]
CHEN Genghua [7115 6342 5478]

ORG: ZHANG and LIU of the Department of Physics, University of Science and Technology of China, Hefei; CHEN of the Institute of Physics, Chinese Academy of Sciences

TITLE: "The Current-Voltage Hysterisis for the Superconducting Crossed-film Tunneling Junction"

SOURCE: Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 34 No 4, Apr 85 pp 429-438

TEXT OF ENGLISH ABSTRACT: We have found that for the superconducting crossed-film tunneling junction, the tunneling electrical current must raise the temperature in the junction area and also produce a nonhomogeneous self-induced magnetic field simultaneously. This causes the superconducting film to transform into an intermediate state. By means of this physical model we can not only explain the hysterisis in I-V curves of nonequilibrium superconducting Pb films and the existence of threshold current I_{t3} revealed in previous experiments, but also predict the existence of the hysterisis, a strange phenomenon, in the usual tunneling I-V curves.

AUTHOR: ZHUANG Songlin [8369 2646 2651]
ZHENG Quan [6774 2938]

ORG: ZHUANG of Shanghai Institute of Optical Instruments; ZHENG of Shanghai University of Science and Technology

TITLE: "The Inverse Source Problem in Partially Coherent Optical Information Processing"

SOURCE: Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 34 No 4, Apr 85 pp 439-446

TEXT OF ENGLISH ABSTRACT: In this paper we establish a mathematical model for describing partially coherent optical processing, and the error transfer formulas are also derived. The mathematical model can be used not only for estimating the error of a restoration image, but also for predicting the optimum source distribution. The necessary and sufficient condition for achieving a non-error restoration image is obtained. We also prove that for a truncation signal, the restoration image can be obtained with arbitrary precision by using an appropriate light source.

AUTHOR: LU Yuzeng [4151 6276 2582]
Y.C. CHENG [6774 5069 1350]

ORG: LU of Chengdu Institute of Radio Engineering; CHENG of the University of Hong Kong

TITLE: "A New Model for the Growth of Silicon Dioxide Layers"

SOURCE: Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 34 No 4, Apr 85 pp 447-454

TEXT OF ENGLISH ABSTRACT: A new model of oxidation is proposed to describe the growth of both thin and thick silicon dioxide layers. The assumption of the model is the presence of an exponential distribution of total net charges during oxidation. In this paper we take into account the influence of the oxide charges and derive a new thermal-oxidation relationship of silicon which agrees reasonably well with experimental data covering both thin and thick oxides. The relationship can be reduced to the well-known formula of Deal and Grove in the limit of thick oxide. With this model we can also explain the effect of an external field on the oxidation rates.

AUTHOR: TANG Jingchang [0781 2529 2490]
HUANG Qi [7806 4860]

ORG: TANG of the Department of Physics, Zhejiang University, Hangzhou; HUANG of the Institute of Physics, Chinese Academy of Sciences

TITLE: "Studies of Fourier-Transform Analysis Method for Energy-dependent Photoelectron Diffraction. I. Se-Ni(001) and S-Ni(001) Systems"

SOURCE: Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 34 No 4, Apr 85 pp 464-475

TEXT OF ENGLISH ABSTRACT: The direct Fourier-transform analysis method for energy-dependent photoelectron diffraction curves of Se-Ni(001) and S-Ni(001) systems has been studied. The effects of different energy ranges in which Fourier-transformation was performed on Δ_α (layer-spacing modification) are considered. The possibility that the surface structure can be determined by using these Δ_α values and FT of experimental EDPD data is discussed.

AUTHOR: LI Mingfu [2621 0682 1788]
REN Shangyuan [0117 1424 0337]
MAO Deqiang [5403 1795 1730]

ORG: LI of the Graduate School, University of Science and Technology of China, Beijing; REN and MAO of the Department of Physics, University of Science and Technology of China, Hefei

TITLE: "Distribution Characteristics of Deep Level Wave Functions in Bloch Space"

SOURCE: Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 34 No 4, Apr 85 pp 547-551

TEXT OF ENGLISH ABSTRACT: A simple method in the framework of Koster-Slater Green's function calculation and central cell defect potential (CCDP) approximation is used to calculate the distribution of deep level wave functions in Bloch space for Si, GaAs and GaP for the first time. Convergence properties are discussed. It is shown that for a definite number of energy bands in the host crystal model, the convergence of deep level wave function calculations is faster than that of deep energy calculations.

9717
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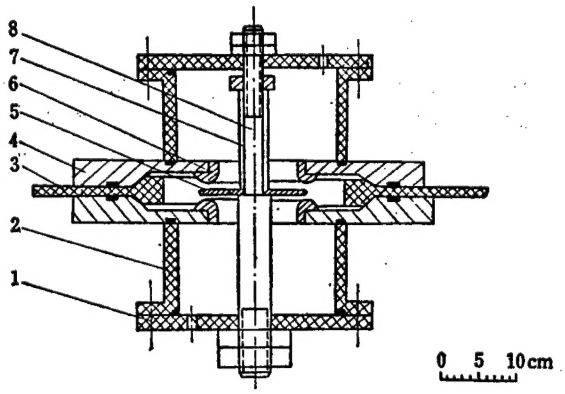
TITLE: "A Low Inductance Field Distortion Short-Circuit Switch"

SOURCE: Beijing WULI [PHYSICS] in Chinese Vol 14, No 4, Apr 85 pp 246-247

ABSTRACT: In a nuclear fusion installation for capacitor discharge, a short-circuit switch is connected parallel to a load inductance so that it can generate unipolarity pulse current. The short-circuit switch is shown in the following figure.



Key: 1. Cover plate; 2. Insulating cylinder; 3. Main insulating plate; 4. Electrode plate; 5. Trigger electrode; 6. Main electrode; 7. Sleeve; 8. Fastening bolt.

The paper goes on to describe the switch with regard to its characteristics of short-circuiting and electrical strength, inductance resistance, current capacity, service life, and trigger circuit. Three other figures show a test circuit for the short-circuiting characteristics of the switch, as well as current waveforms with and without short-circuiting. One table lists puncture voltages for the upper and lower switch gaps.

10424
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TITLE: "Neutron Guide Tubes"

SOURCE: Beijing WULI [PHYSICS] in Chinese Vol 14, No 4, Apr 85 pp 221-226

ABSTRACT: The neutron guide tube was developed in the 1970's on the basis of a reactor technology for neutron passage and by utilizing neutrons at wavelengths greater than 1 Å. Thus, the research results can be qualitatively and quantitatively enhanced without increasing the operating power of a laboratory reactor. The paper describes the working principle, structure and factors influencing the transmission coefficient of neutron tubes, as well as background and screen. Neutron tubes can be used to generate polarized neutrons although the manufacture of polarized guide tube is relatively difficult from the engineering viewpoint. Three figures show the geometric relationship of a curved guide tube, different types of reflection in the tube, and the neutron passage rates. One table shows the attenuation of fast neutrons and thermal neutrons. The author thanks Yang Zhen [2799 2823] for his assistance in writing the paper.

10424
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TITLE: "Long Life Corona-Preionization XeCl Excimer Laser"

SOURCE: Beijing WULI [PHYSICS] in Chinese Vol 14, No 4, Apr 85 pp 244-245

ABSTRACT: The fast discharge pumping excimer laser is simple in structure and can operate at high pulse repetition rate as principal feasible equipment for medium and small lasers in the ultraviolate wave region. The paper reports an effective corona preionization design in increasing the laser output energy and prolonging laser operating life. The XeCl excimer laser is low in corrosion while the improved corona preionization structure can considerably reduce pollution by discharge sputtering. In an experiment, a gas tank was connected and some of the working gas was exchanged daily. The laser operated for more than 200 hours as the output power was reduced by 20 percent with only slight contamination at the laser chamber lens. Three figures show the laser installation, corona preionization structure types, and the relationship between laser pulse output energy and charge voltage.

10424
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Preventive Medicine

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TITLE: "A Study of Enterotoxin Plasmids Transmission of Escherichia Coli"

SOURCE: Beijing ZHONGHUA YUFANG YIXUE ZAZHI [CHINESE JOURNAL OF PREVENTIVE MEDICINE] in Chinese No 1, 25 Jan 85 pp 12-13

TEXT OF ENGLISH ABSTRACT: By means of mixed culture of 15 strains ETEC (donor strains) with 9 strains of non-enterotoxigenic recipient strains, it was demonstrated that enterotoxin (Ent) plasmids of 5 strains of E. coli were transmitted to nonenterotoxigenic E. coli and Salmonella typhimurium through conjugation. One of the four strains of non-enterotoxigenic E. coli and one of the five strains of nonenterotoxigenic Salmonella typhimurium obtained the Ent plasmids this way. The Ent plasmids transmission rates ranged from 4.8 to 15.0 percent.

By means of drug-resistance selection, Ent plasmids from 6 of 14 strains ETEC (donor-strains) were trasmitted to 3 strains of non-enterotoxigenic E. coli (recipient strains) through conjugation. The Ent plasmids transmission rate was over 50 percent, which was significantly higher than that obtained by mixed culture method.

12949
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